# The Engineer

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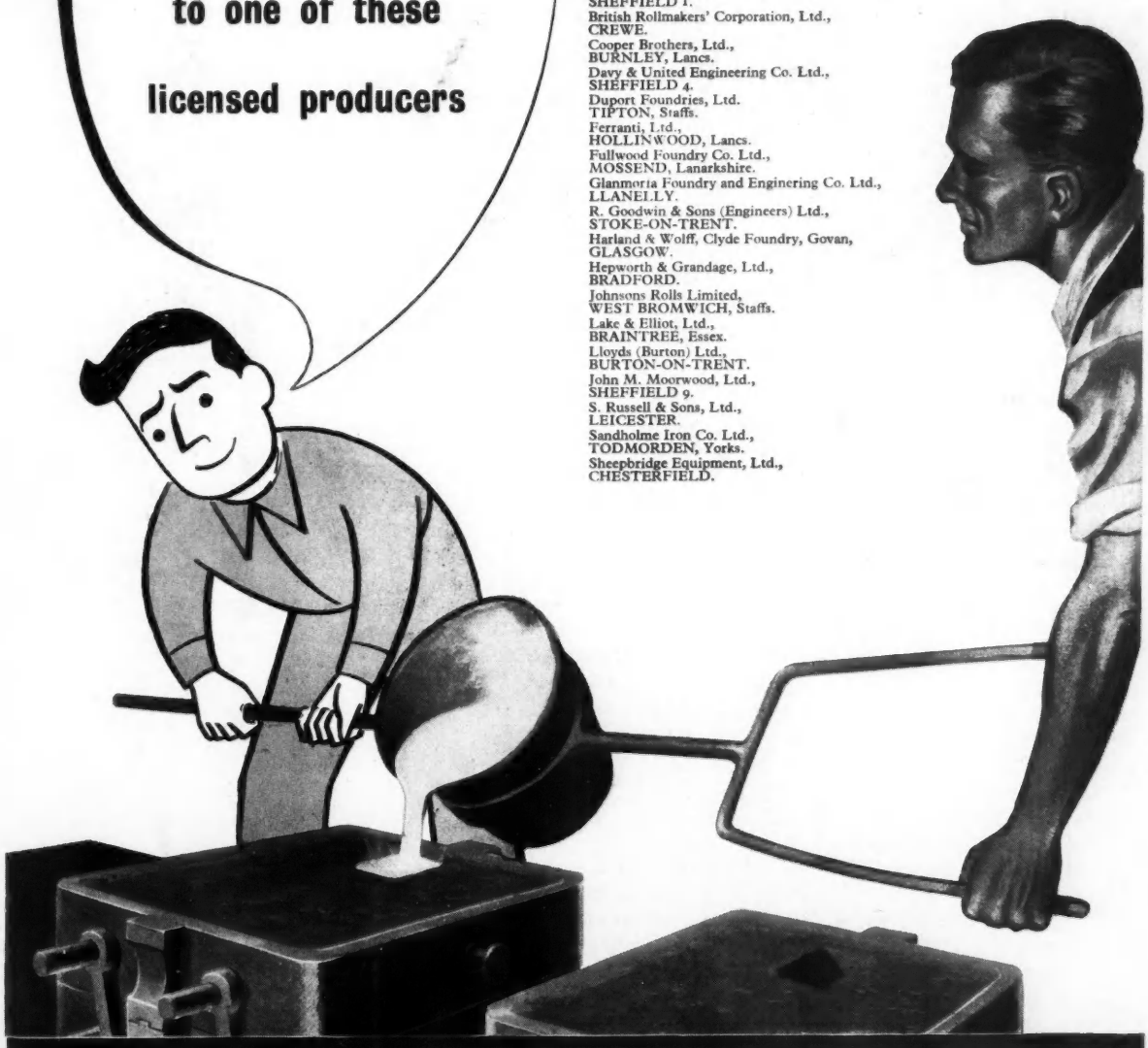

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# THE ENGINEER

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## RAILWAY SIGNAL ENGINEERING

Shortly after the announcement of the British Transport Commission plan for modernisation of the railways we published a leading article under the title of "Railway Engineering Manpower"; for manpower then seemed to us the key to the whole situation. Subsequent events have certainly strengthened that belief, and there has surely never previously been a time when the railways themselves, and the large contracting firms have devoted so much time, and money, towards recruiting of staff. The British Transport Commission has recently issued a handsomely produced brochure illustrating the attractions of railway signal engineering as a career, and the significance of this move may in some ways be linked with certain passages in the presidential address of Mr. J. C. Kubale to the Institution of Railway Signal Engineers in April last It should be emphasised however that the link-up is incidental, or perhaps coincidental, since Mr. Kubale is a signal contractor and not a railwayman. For many years we have held the view that signalling, perhaps more than any form of motive power, is the kingpin of the whole fabric of modern railway operating, and the issue of this brochure, combined with the recruiting campaigns in progress in the various regions seems evidence that at last financial backing on a large scale is being given to this branch of railway engineering. In view of the numerous technical advances made in the last thirty years it may have seemed astonishing to outside observers that the art of signalling had not been exploited to a far greater extent in this country, to the advantage of railway operation. But the plain fact is that the necessary cash was not forthcoming—a point quietly drawn by Mr. Kubale in his address.

Now, ironically enough, the cash is available, but the staff is barely adequate to prepare the schemes. The attractive prospects outlined in the brochure seem to be an understatement rather than an exaggeration of the opportunities to be grasped by ambitious young men. The signal engineer of to-day has to be a jack of many trades. The brochure describes his job as "a form of light electrical engineering where mechanical knowledge is also of great value and which calls for ingenuity, imagination, and a sound knowledge of engineering principles rather than high mathematical ability." Furthermore, although the basic safety principles remain, the changing face of railway motive power arrangements combined with present economic conditions are, on the one hand, demanding changed signalling technique, in details of control and protective devices and, on the other, opening the way for spectacular savings on items that are now considered basic costs. To quote two practical examples: the adoption of electric traction at high voltage and commercial frequency means an entirely new design of track circuit; and as regards economics, we need only quote the instance of cable. In his presidential address Mr. Kubale referred to the way in which the cost of a signalling installation is split up, and quoted typical figures to show that in a modern power signalling plant cabling accounts for 26 per cent of the total cost, a proportion nearly equal to the cost of the elaborate specialist equipment in the signalbox itself. In recent years the trend towards concentration of control, and the improved traffic regulation that is made possible thereby, has been accompanied by a considerable increase in the cost and extent of the wiring, and there is certainly scope for innovation and ingenuity if this cost is to be reduced.

One method of reducing cable costs in a scheme of remote control is to use the coded system of transmission and indication known as centralised traffic control, or C.T.C., as it is generally called. In the past the objection to this system in busy areas has been the time taken for the transmission of control codes, and the time taken for indication codes to come in. Nowadays, however, means are becoming available, for greatly speeding up the time of coding, to such an extent indeed as to make it almost instantaneous; such a technique may well lead to the reconsideration of some schemes of C.T.C. In any event the prospects before the signal engineering profession seem wellnigh limitless. The gradual equipping of freight trains of all kinds with continuous brakes is expected to result in a general speeding up of service; but improved signalling will be necessary to make such acceleration of service a practical reality, irrespective of whether steam, diesel, or electric traction is employed. Furthermore, the signal engineer's work is not confined to the running lines. The equip-

ment of marshalling yards is an increasingly important facet of his work. The need to effect economies in operation is essential, and as the British Transport Commission brochure emphasises, the trend towards automation in industry finds its parallel in railway traffic working in modern signalling schemes where concentration of control results in important economies in operational manpower.

### NAVAL BASES AND MARINE NUCLEAR PROPULSION

Speaking at Sydney a few weeks ago, Admiral the Earl Mountbatten forecast that in a hundred years' time atomic power would be the only form of power for ships. No doubt the First Sea Lord had in mind the long period which elapsed before sailing ships gave way to steam vessels. But, in view of the developments in reactors since the war, it was hardly an optimistic forecast and surely no indication of the degree of urgency which the Government attaches to the subject. Uranium is no longer scarce. New sources of supply are being discovered in various parts of the world. Moreover, concentrated fuel will soon become available from the diffusion plant at Capenhurst and various atomic reactors. Designers can thus think in terms of fast neutron reactors, with cores no larger than a 40-gallon petrol drum, which makes practicable the installation of an atomic power plant in a relatively small vessel. For this country, in fact, the only substantial obstacle still to be overcome is the very high cost of manufacturing and installing the plant. This applies both to warships and merchant vessels, though in the case of the latter solutions have also to be found for problems connected with maintenance and safety. With the present rate of progress, however, it is by no means improbable that within ten to fifteen years shipowners will be seriously considering atomic power plants as an alternative to the steam turbine, at least for some classes of ships. With atomic power plants vessels could steam many thousands of miles without refuelling. They would be much faster and, having no fuel tanks, much more space would be available for passengers or cargo. On the other hand, it is usually more important to convey goods cheaply rather than speedily to their destination and cargo vessels could make no use of their expensive power plant for days on end while in harbour, loading or unloading cargo.

The United States with her ample resources has already made a good start. At the present time she has a small cruiser, a large aircraft carrier and eight submarines built or on order, with atomic power plants. Britain has to consider very carefully the operational value of such vessels in relation to other and more essential defence commitments. Gone are the days when the Press and public could agitate successfully with the slogan "we want eight and we won't wait." We did not worry about the cost of building eight "Dreadnought" battleships to maintain our superiority over the German Navy. But the Royal Navy is no longer our only vital defence commitment—the V-bomber deterrent, home defence and a large army on the Continent are equally important. Now, however, a new and sinister cloud looms over the horizon—the probable loss of overseas bases because of the desire of the Eastern peoples to govern themselves and be independent. Having given up the right to use Alexandria, Port Said and Suez in time of war we are now faced with the loss of Trincomalee and even the possibility of losing Singapore. Agreements may well be reached entitling us to use one or more of these bases in war and to maintain forces there in peace, but they would not necessarily be valid with a change in local government. The possession of bases, or the lack of them, has been the dominant factor in almost every war in which this country has been engaged. The protection of our seaborne trade has always been our prior commitment, and it could not have been provided without bases in every sea.

In this nuclear age, both the Royal Navy and the United States Navy plan to provide mobile support as far as possible as an alternative to fixed bases. Indeed, the American Fleet in the Mediterranean relies entirely on a fleet train of ships which provide fuel and stores and can carry out major repairs; though one sometimes wonders whether the results would have been so successful without the facilities available at Malta. But in the absence of bases in an operational area, the task of detached ships—patrol vessels and escort vessels—becomes impossible. Fuel is the chief problem—sufficient fuel to enable them to reach one of the terminal bases which will always be available as long as the British Commonwealth remains in being. There is and can be only one solution—atomic power plants for frigates, destroyers and cruisers and it is much to be hoped that the new company formed to plan a marine nuclear power plant will pay particular attention to the plant suitable for such vessels. It is the Admiralty's present intention to install the first of these plants in a submarine, presumably because the Americans are satisfied with the performance of their own submarine, the "Nautilus." From the fuel aspect a submarine is the last kind of vessel to require such a plant; even a medium-size submarine with a conventional diesel plant has a range of 10,000 miles at economical speed. Under modern conditions, however, she should be capable of high submerged speed for a period long enough to evade an anti-submarine vessel or to attack a target, with aircraft cover, reported 100 miles away. At the end of the war the Germans had on order 100 submarines with engines employing hydrogen peroxide, which, when high submerged speed was required, would give them a speed of 25 knots for nearly seven hours—a performance that would seem to meet these essential requirements. Two submarines with engines of a similar kind are now being completed for the Royal Navy. Ostensibly intended for the training of personnel in operations against high-speed submarines, it is inconceivable that these two ships would have been built at a cost of several hundred thousand pounds—possibly millions of pounds—had the Admiralty not been convinced of their value in war. In view of the now urgent need for a much increased cruising radius for cruisers and lesser ships, there seems good reason for postponing a final decision until these two experimental submarines have been thoroughly tried out in exercises under active service conditions.

## The Engineer

### 100 Years Ago

(JUNE 20, 1856)

"THE BRIDGE IN THE PARK"

"The bridge across the Ornamental Water in St. James's Park may be considered as *un fait accompli*. A vote of £3,500, to be expended in its erection, has passed the House, and a proposal to reconsider that vote, and to postpone a discussion upon the question generally, has been defeated. The bridge is, however, to be devoted exclusively to pedestrians; and thus one of the most urgent objections to the scheme, originally proposed by Sir Benjamin Hall, has been removed. If we are to have a bridge at all, it is well that we are to be spared the bustle, and the dust, and the noise, one or all of which inconveniences must generally attend a rapid carriage traffic; and if it be true, as represented by the first Minister and the Minister of Works, that public requirements are urgent, and that those requirements can only be met by the erection of the bridge, the sooner we have it thrown across the water the better for all of us.

"The question as to whether good taste must be made subservient to public convenience is one well worthy of consideration; but, in the case before us, we do not think it necessary to discuss the point. As the bridge is decided upon, we do not think it is a matter of impossibility to erect a structure which shall not only not be offensive to people of good taste, but rather tend to increase the beauty of the gardens. Lord Palmerston said truly, that a light suspension bridge is one of the most beautiful structures we can make, and if a premium be offered for the best design for the proposed bridge, we have not the slightest doubt many designs will be offered worthy of the attentive consideration of Sir Benjamin Hall, and a very ample opportunity will be afforded him for proving himself the man of good taste by selecting that one which, when carried into execution, shall not only meet the requirements of the pedestrianising public, but satisfy the present malcontents, and convince them that they have been hasty in their conclusions, when they considered the bridge would be a deformity to the park."

# A Seven Day Journal

### Fifth World Power Conference

ON page 705 we begin a survey of the groups of papers presented at the fifth World Power Conference, which is being held this week in Vienna. The opening plenary session of the conference took place last Sunday, in the State Opera House, Vienna, when Sir Harold Hartley delivered his presidential address. In the course of his address, Sir Harold spoke of the "closer knowledge of Nature's erratic distribution of her gifts among the countries of the world," which had brought home the inescapable community of interest of nations. In this modern world, he continued, energy directly or indirectly was playing an important part and often it might prove to be the limiting factor in development; yet there was a growing awareness of the need of energy, and a growing anxiety in many countries as to how that need could be met. Sir Harold went on to say that the discovery of the possibility of harnessing nuclear energy had come at a most timely moment. The nuclear energy available in uranium and thorium had multiplied the energy resources of the world many fold. It would in time make ample supplies of energy available at places where the cost of transport of traditional fuels might be prohibitive. Sir Harold ended his address by emphasising that in this rapidly changing world the World Power Conference must not be content to record past achievements except as a pointer to the future. Its value would depend on forecasting the energy problems of the future and the means of their solution. One of the dangers of this complex civilisation of ours, with its ever-growing needs, Sir Harold commented, was that we might be caught unawares. That was particularly true of the field of energy which needed such long-term planning and investment.

### Hydraulics Research

THE Department of Scientific and Industrial Research has published the report of the Hydraulics Research Board for 1955. It gives some account of the work which is being done at the Hydraulics Research Station at Wallingford on problems concerned with loose boundary hydraulics. This research includes investigations of coast erosion, problems of siltation in the Thames, and other estuaries, land reclamation schemes and flooding. Much of the station's effort, the report says, is devoted to the study of waterways and harbours by means of tidal models. The main hall of the research station, with a floor space 300ft by 200ft, came into use last year, and in it there have been constructed models to investigate problems of flooding in the River Severn, near Shrewsbury, and in the tidal reaches of the River Trent. But, the report explains, there is still need for more space to enable the Board to carry out urgently needed background research into coast erosion. The report makes special reference to the suggested scheme for the protection of London and its environs from such flooding as occurred in the storm surge of January, 1953, which has been the subject of further research. This scheme involves the building of a system of barrage gates about 20 miles downstream of London, which could be closed if there was danger of flooding in the London area. Experiments have been carried out on a tidal scale model of the River Thames to discover the merits of various sites for the suggested barrage, to compare the performance of various kinds of barrage gates, and to discover the effects achieved by closing them at varying times before high water. There is also given in the report some account of the considerable amount of work which is being done at the research station on problems associated with various harbour and hydro-electric schemes overseas.

### London's Approach Roads

LAST Friday, the Minister of Transport and Civil Aviation, Mr. Harold Watkinson, visited Ilford to see the progress which is being made on a scheme to reconstruct a half-mile section of Eastern Avenue, at Newbury Park. The project involves the construction of twin carriageways as already exist on the adjoining lengths of the road, a road which, it is stated, carries 22,000 vehicles daily. Whilst at Ilford, the Minister named five other road improvement schemes which it is hoped will be started during the next few weeks on the outskirts of London. They are: a £251,000 scheme for the mile-long section of Watford Way (A.1) between Page Street and Mill Hill Circus; a £200,000 scheme for extending the twin carriageways on the Great Cambridge Road (A.10) northward from Bury Street, Edmonton, to Carterhatch Lane, Enfield, a distance of about 2 miles; a £250,000 scheme to provide twin carriageways on Western Avenue, between Greenford Railway Bridge and Alperton Lane, a distance of more than a mile; the reconstruction of the junction of Barnet by-pass (A.1) and Archway Road at a cost of £40,000, and a £232,000 London County Council scheme for widening a section of Roehampton Lane, near Queen Mary's Hospital. The Minister said that his department was re-examining the road needs of the country in the light of the new traffic densities expected. Until 1954 there had not been a comprehensive and reliable traffic census in this country for sixteen years. The 1954 detailed traffic census had shown that in order to cope with traffic requirements, it was necessary to design roads to carry two-and-a-half times the 1938 traffic.

### Redevelopment Around St. Paul's Cathedral

AT its meeting last Tuesday the London County Council approved its town planning committee's views on the report prepared by Sir William Holford on the redevelopment of the area surrounding St. Paul's Cathedral. In commenting favourably on the scheme proposed, the committee said it would both satisfy practical needs and look attractive at each phase of its development, whereas the formal solution previously proposed for the western forecourt would not only be out of character in tending to isolate the Cathedral, but would present an unsatisfactory aspect during the lengthy period of construction which would be required. The committee has suggested certain minor departures from the proposals in order to improve road traffic. In its effect on property the scheme is stated to have three great advantages: of being carefully phased over a number of years, so that war-damaged sites are dealt with first; of combining as far as possible planning consents already given into a comprehensive pattern; and of permitting the phasing of new construction so as best to serve the needs of the owners and occupiers. The cost of acquisition of the whole area, of which over 3½ acres may be preserved as open spaces, is estimated at £10,000,000. This figure excludes those parts already owned by the City Corporation and the Dean and Chapter of St. Paul's.

### International Electrotechnical Commission

NEXT Tuesday, the twenty-first general meeting of the International Electrotechnical Commission will open at Munich. There are 110 British delegates from the electrical and electronics industries, trade and research associations, transport undertakings and Government departments. At the meeting twenty-six countries from all parts of the world, including the Commonwealth nations, the United States and Russia, will be represented. The discussions will cover all aspects of international standardisations in the electrical field. The British delegation will be led by Colonel B. H. Leeson, who is chairman of the British National Committee of the I.E.C. and director of the BEAMA, and by Mr. H. A. R. Binney, director of the British Standards Institution. Next Friday, Mr. Clarence H. Linder, an executive of the General Electric Company of America, will present the Charles le Maistre Memorial Lecture, which this year is on the general theme of international electrical standardisation. An extensive programme of technical visits to works and laboratories, and social and official functions has also been arranged.

### Edmund B. Wedmore, C.B.E., M.I.E.E., F.Inst.P.

WE learn with regret that Mr. E. B. Wedmore, who was formerly director of the Electrical Research Association, died on Saturday, June 16th, at the age of eighty. Edmund Basil Wedmore was born in Bristol on January 24, 1876, and was educated privately and at University College, Bristol. He began his career in 1895 as a lecturer and demonstrator at Finsbury Technical College. Four years later he joined the British Thomson-Houston Company, Ltd., as a design engineer, and he remained with the firm for twenty years. Then, from 1919 to 1921, he served as technical officer on the Electrical Research Committee and in 1921 he was appointed director and secretary of the newly-established British Electrical and Allied Industries Research Association. From then until 1944, when he retired, he made numerous contributions to electrical knowledge, particularly in the field of switchgear. His published work included many papers to the Institution of Electrical Engineers. In 1896 he was awarded a Students' Premium and in 1912 he published a paper with W. B. Hird discussing the weight efficiency of electric motors and prime movers. A paper on automatic protective switchgear for a.c. systems earned him the John Hopkinson premium in 1914. He was awarded an I.E.E. premium for his paper, in 1918, on the control of large amounts of power. In 1929 he (together with his co-authors, W. B. Whitney and C. E. R. Bruce) was awarded the I.E.E. Kelvin premium for a paper dealing with researches on circuit breaking. He became an associate of the Institution of Electrical Engineers in 1897, an associate member in 1902 and a member in 1912. In 1941 he was elected a member of council. He received the C.B.E. in 1938. In his main recreation, bee-keeping, he earned distinction by his many contributions to the knowledge of the art and he was the author of "A Manual of Bee-keeping" and other standard works on the subject.

# Self-Priming Pumps

By SAMI MIKHAIL, M.Sc., D.I.C., Ph.D.

*This is a summary of research carried out in the hydraulics laboratory of the Faculty of Engineering of Cairo University, Giza, under the supervision of Professor H. Addison. The performances of the following pumps are compared: a jet type self-priming centrifugal pump, a diffuser-type self-priming centrifugal pump, and a water ring pump.*

THE increased popularity of self-priming pumps, in recent years, is the logical outcome of the greatly increased demand for a centrifugal pump which would have the power to prime itself automatically and thus would be able to serve various conditions where the conventional methods of priming are inadequate. Although self-priming pumping sets are built in a great variety of types, the more important are :

(1) The jet type self-priming centrifugal pump.

(2) The diffuser type self-priming centrifugal pump.

(3) The water ring pump.

The casing of both the centrifugal pumps is made to include a reservoir for priming water, which is recirculated through the pump during priming. In the jet pump, water is circulated in the form of a jet projected from a priming nozzle into the eye of the impeller. In the diffuser pump, priming holes are drilled in the pump cover to allow water to circulate between the casing and the inside of the impeller. This recirculation of water permits the pump to act as a wet vacuum pump when started until all the air enclosed in the suction system has been exhausted. Water ring pumps are being more widely used as water pumps, in spite of their low efficiency, owing to the advantage that they are self-priming.

As the literature on self-priming pumps is very limited, while many facts related to them are not yet clear, it was decided to make experiments in the Hydraulics Laboratory of the Faculty of Engineering, Giza, with the purpose of obtaining comparative information which would help to investigate their modes of operation and to make comparison between the different kinds of pumps. In particular it was intended to assess the influence of different design features on the priming speed of each pump and to suggest means to improve this speed.

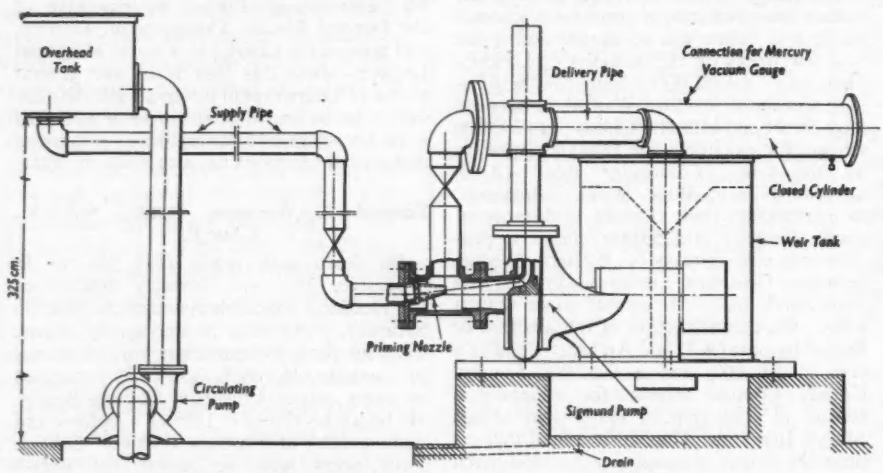



Fig. 1—Details of first test-bed consisting of standard pump and built-in nozzle

## System of Testing

Owing to constructional difficulties it was not possible to run all the pumps under actual suction lift conditions. Hence, an indirect method of comparison was adopted. The characteristics of different pumps were compared when working as vacuum pumps (i.e. the weight of air exhausted per second was measured under different values of negative pressure).

Owing to the very small air capacity of the two self-priming centrifugal pumps, it was not possible to use the orifice-meter method. Instead, the well-known " receiver method" was adopted. It consists in pumping air out of a receiver of known volume, noting the time intervals between the passing of the gauge on the receiver through values of negative pressure.

The air receiver chosen was a 6in diameter steel pipe of 2·6m length. The rates of pressure and temperature drop while exhausting it were very slow, and its surface area was large relative to its volume, so that any drop in temperature of the air, due to the expansion of volume, was quickly restored by conduction of heat from the atmosphere. Thus the temperature of the air within was held close to a constant value. Comparison between the results given by this method and that given by orifice-meter method, while testing the water ring pump, proved the method to yield satisfactory results.

Further, a method of calculation was evolved, for estimating the true time of priming different pumps. By calculating the weight of air enclosed in vertical suction pipes for different values of suction lift and by using the known results of the pumps' capacity as vacuum pumps, it was possible to calculate the time taken by each pump to exhaust any given suction pipe, i.e. the time of priming. Evidence in support of this method of calculation has been fairly conclusive.

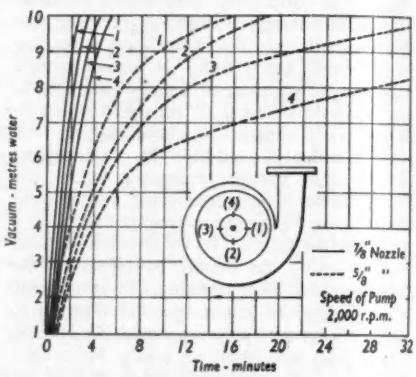



Fig. 3—Time-vacuum curves for different nozzle positions

## Jet Type Self-Priming Centrifugal Pump

Two examples of this pump were tested.

Pump *A* (Fig. 1) consisted of a standard non-priming 3in/3in centrifugal pump, with a built-in priming nozzle.

Pump *B* (Fig. 2) was a commercial, self-

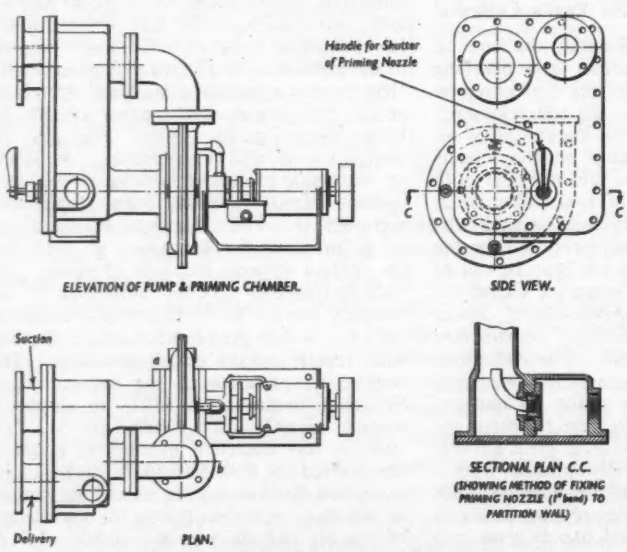



Fig. 2—Jet self-priming centrifugal pump

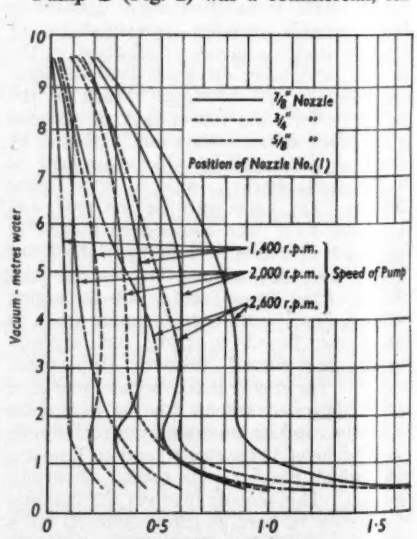



Fig. 4—Weight of air exhausted per second for different values of vacuum

contained 3in/4in pump, made by Joseph Evans and Son (Wolverhampton), Ltd. The 1in diameter pipe bend nozzle seen in the drawing is screwed in near the bottom of the partition wall, dividing the priming tank, and receives its supply from the left-hand side of the tank. This tank is bolted to the suction flange of the standard pump.

Pump *A* was so tested, in order to assess the influence of design features on performance of this pump, as to avoid any interference from a rise of the circulating water temperature (which was noticed to happen when only a limited amount of circulating water was used in pump *B*). The condition was fulfilled by supplying the nozzle with a continuous supply of fresh water.

The tests on pump *A* revealed that the factors governing priming operation of this pump were :

(1) Position of priming nozzle (i.e. the point where the jet projecting from the nozzle would enter the eye of impeller). Fig. 3, which indicates four situations of the nozzle, is a typical example of the results obtained with this pump. Position 1 is revealed to be the best position, as it gives the biggest rate of air exhaustion, while position 4 is the worst.

(2) Diameter of nozzle : as is clear from Fig. 4, which shows characteristic curves of this pump as a vacuum pump, the bigger the nozzle diameter the bigger is the rate of air exhaustion per second.

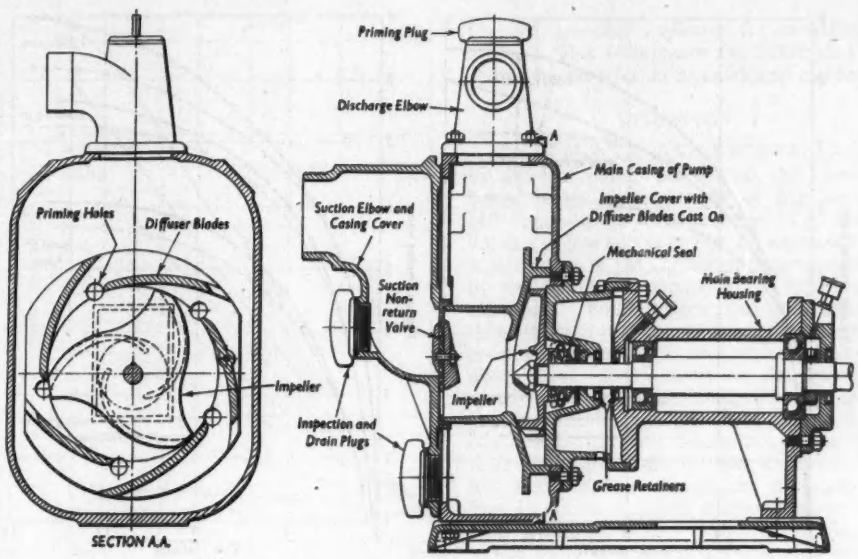



Fig. 7—Diffuser self-priming pump

(3) Speed of pump : Fig. 4 also shows that the higher the speed of pump, the higher is the amount of air exhausted per second, their relation being nearly parabolic.

During all tests on pump *B* it was noticed that the temperature of the circulation water rose with rise of vacuum inside the air receiver and reached its maximum value at end of exhaustion. As the amount of circulation water is limited, the water is forced to recirculate through the pump many times, during exhaustion, and as most of the input energy of the driving motor is wasted in eddy and friction losses and hence converted into heat energy, this heat energy makes the temperature of the water rise. Naturally the higher the speed of pump the bigger will be the friction losses and the higher the rise in water temperature, as shown in Fig. 5. By comparing the results from pump *B* with those from pump *A*, it can be seen that the higher the rise of water temperature the worse becomes the rate of air exhaustion of the pump. Furthermore, the rise of water temperature has the unfavourable effect of decreasing the value of the maximum vacuum which can be produced inside the air container. For both pumps *A* and *B*, the maximum vacuum was found to be equal to atmospheric pressure minus the value of the water vapour pressure corresponding to the temperature of the water at the end of exhaustion. A rise of water temperature, of course, increases the value of water vapour pressure and thus reduces the value of the limiting vacuum (see Fig. 5), and the temperature rise thus

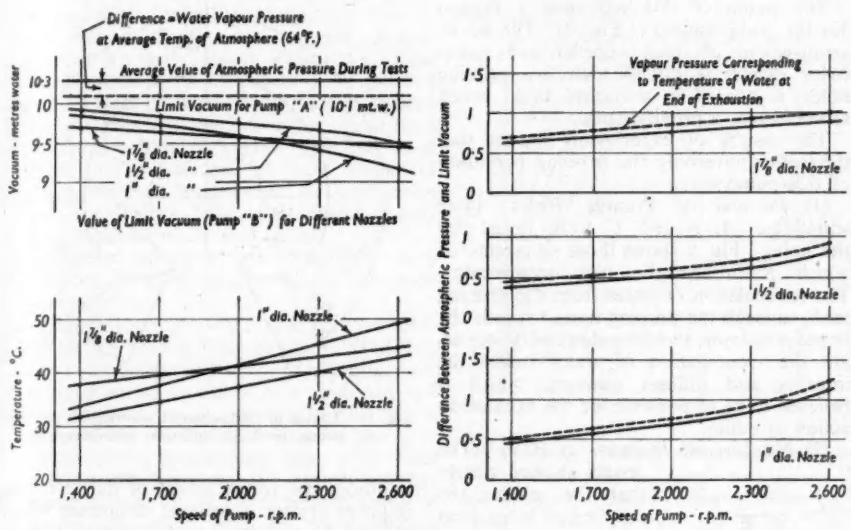

Difference = Water Vapour Pressure at Average Temp. of Atmosphere (64°F.)
Average Value of Atmospheric Pressure During Tests
Limit Vacuum for Pump "A" ( 10·1 mt.w.)
1⅞" dia. Nozzle
1½" dia. "
1" dia. "
Vacuum - metres water
Value of Limit Vacuum (Pump "B") for Different Nozzles
1⅞" dia. Nozzle
1" dia. Nozzle
1½" dia. Nozzle
Temperature - °C.
Speed of Pump - r.p.m.
Vapour Pressure Corresponding to Temperature of Water at End of Exhaustion
1⅞" dia. Nozzle
1½" dia. Nozzle
1" dia. Nozzle
Difference Between Atmospheric Pressure and Limit Vacuum
Speed of Pump - r.p.m.

Fig. 5

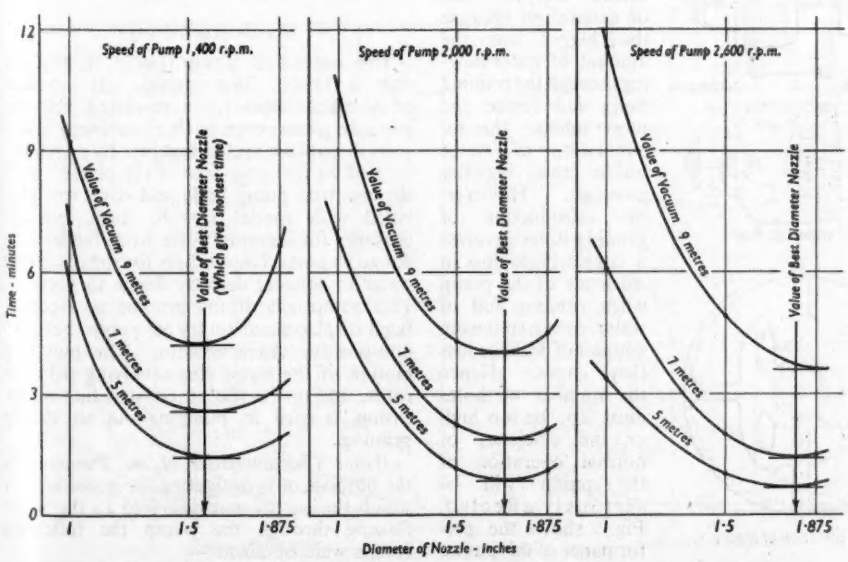

Speed of Pump 1,400 r.p.m.
Speed of Pump 2,000 r.p.m.
Speed of Pump 2,600 r.p.m.
Value of Vacuum 9 metres
Value of Best Diameter Nozzle (Which gives shortest time)
7 metres
5 metres
Time - minutes
Diameter of Nozzle - inches

Fig. 6—Time of exhaustion for different values of vacuum for different nozzle diameters

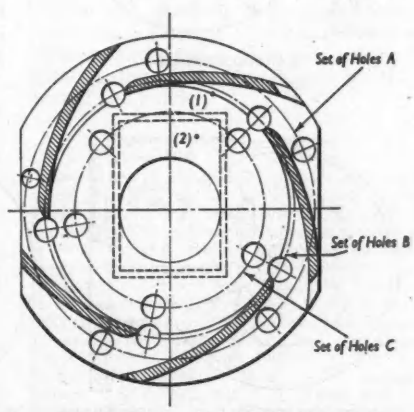



Fig. 8—Details of different arrangements of priming holes drilled in pump cover of pump *C*

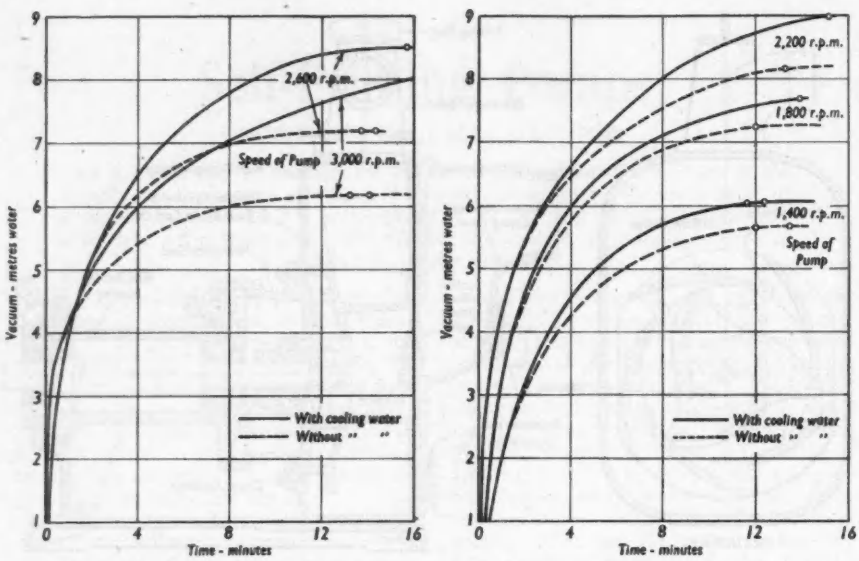



Fig. 9—Time-vacuum curves with and without cooling water for different speeds of pump

determines the value of the maximum suction lift the pump is able to prime against.

Undoubtedly, the smaller the volume of the priming tank the higher will be the rise of water temperature during priming, as the amount of heat energy will be imparted to a smaller amount of water. In short the priming tank should not be so small as to decrease seriously the rate of air exhaustion. On the other hand, it should not be too large, as the greater its size the bulkier and costlier it will be.

Another observation recorded was that there is an optimum nozzle diameter which gives the shortest time of exhaustion, as can be noticed from Fig. 6. The value of this optimum nozzle diameter varies both with the speed of pump and with the volume of the priming tank.

Furthermore, the water passages through the priming tank should be designed with care to ensure minimum energy losses for water flowing through them, both during priming and during normal running of the pump. In pump *B* the loss of efficiency in normal running due to these losses reached a value of about 6 per cent at maximum efficiency point.

### Diffuser Type Self-Priming Centrifugal Pump

The pump of this type was a Pegson 3in/3in pump (pump *C*, Fig. 7). The whole arrangement of open impeller and pump cover (which is drilled with five priming holes) is housed in a vertical tank, which serves also as a priming tank.

The results of experiments showed that the factors governing the priming operation of this pump were:

(1) *Position of Priming Holes:* three situations, *A*, *B* and *C* were tested for the holes. Fig. 8 shows those situations, of which *B* proved the best arrangement. The recirculation of water from the priming tank, through the priming holes towards the impeller interior, should undoubtedly accelerate the recirculation of water inside the impeller and diffuser passages, which is believed to be responsible for the exhaustion action of pump.

(2) *Number and Diameter of Holes.*—The results showed clearly that the greater the number of holes (and the bigger the diameter of the holes also) the smaller was the time of exhaustion because the bigger was the amount of water flowing through the priming holes and hence the more intense the recirculation of water inside the impeller passages. However, the introduction of priming holes involves a considerable loss in efficiency of the pump when running full of water, owing to the big amount of leakage loss they cause. Hence the number of holes must not be too high or the efficiency of normal operation of the pump will be seriously affected. Fig. 9 shows the performance of this pump, with and without introducing cooling water during exhaustion. It illustrates clearly the bad effects of the rise of water temperature which proved excessive owing to the small volume of the priming tank at 7·5 litres. Limiting vacua attained were not so high as those recorded in the jet type pump. It was noticed also that at speed of 2200 r.p.m. the limiting vacuum and the rate of air exhaustion reached their maximum values relative to either greater or smaller speeds.

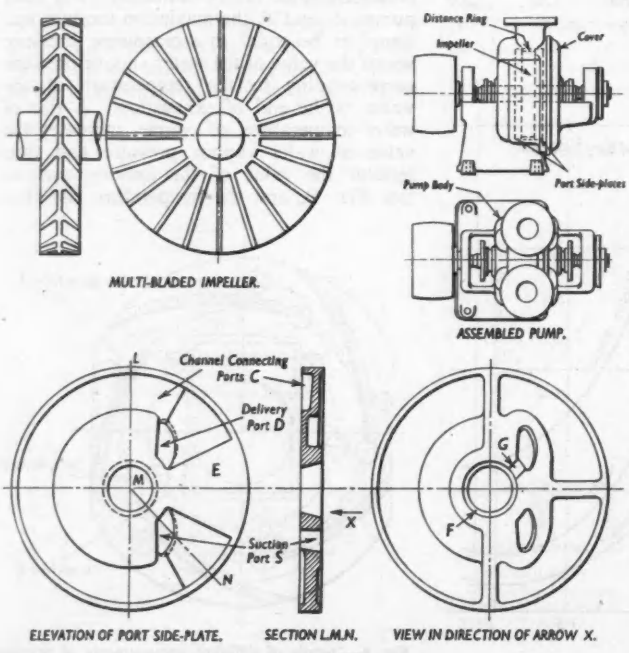



Fig. 10—Details of water-ring pump

### Physical Principle Underlying Priming Action

It is clear from gathered information, that the operation of both centrifugal pumps as vacuum pumps depends on the principle of the transfer of momentum. In the jet type pump the rapidly moving impeller blades cut through the priming jet and break it into a dense spray of water which gives part of its momentum to the air within the impeller eye, while sweeping through the impeller passages. In the diffuser type pump the circulation of water inside the impeller is accelerated by circulation of water between the priming tank and the inside of the impeller through the priming holes. Part of the momentum of this circulating water is transferred to the air and thus enables it to pass through the pump. In addition, the vortex action of the revolving impeller creates a pressure difference which induces air to flow from the suction pipe to the impeller, where it will be mixed with water and then pumped out.

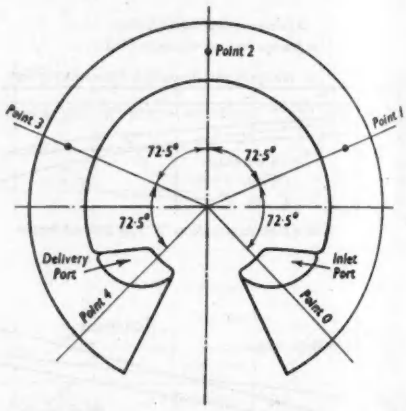



Fig. 11—Layout of guide channel, showing the positions of points used for pressure measurement

### Water-Ring Pump

The water-ring pump (pump *D*, Fig. 10) was a Gilkes 2½in pump. It consists of a multi-bladed rotor revolving between two side plates, each having a delivery and a suction port connected together by a channel formed on the inner face of the plates. Both the cast iron pump body and cover are provided with special ribs to form separate passages for entering water from the suction flange to ports *S* and others for the discharge water to connect delivery flange to ports *D*. This pump acts during priming as a centrifugal displacement rotary air pump, but with non-positive characteristics. The pulsating motion of the water ring revolving with the rotor, due to the special construction of the casing, is used in pumping out air during priming.

*Water Characteristics of the Pump.*—For the purpose of investigating the procedure by which the energy was delivered to the water flowing through the pump the following results were obtained:—

(1) Pressure distribution along one of the

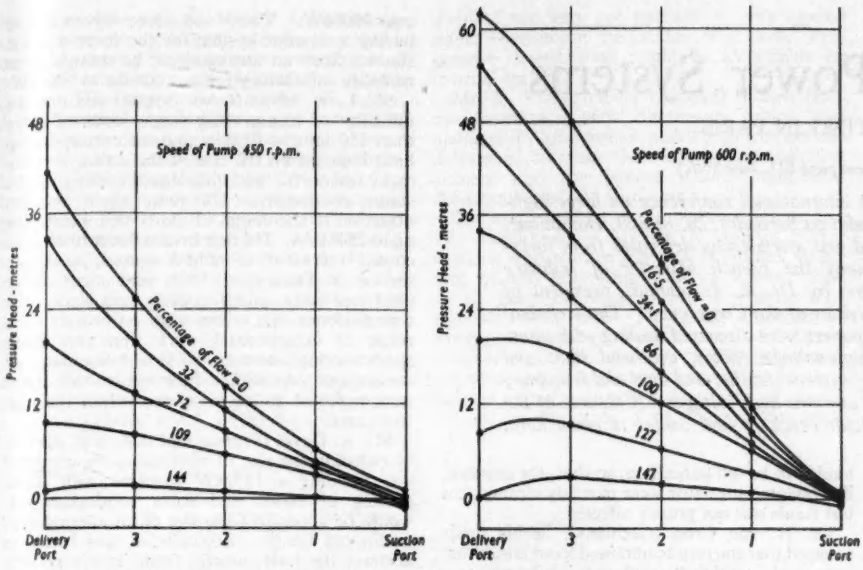



**Fig. 12—Pressure distribution along guide channel for different rates of flow**

guide channels (Fig. 11). The measuring points are points 1, 2, 3 shown in the figure. The pressures at both inlet and outlet ports were assumed to be equal to the pressure at suction and delivery flanges of the pump respectively. From Fig. 12 it is clear that the distribution of pressure along the channel is always nearly linear except for some inconsistence between points 3, 4 and 0, 1 at high rates of flow. This discrepancy can be attributed to the previously mentioned assumption, which implies that the head losses in the passages between flanges of pump and the ports inside the port pieces can be neglected. This assumption is only reasonable for small rates of flow.

(2) The magnitude and direction of flow velocity of water streams inside the guide channel.

All measurements were taken across a vertical section passing through point 2 (Fig. 11). The components of velocity in two directions were measured by means of a pitot tube and then the resultant was found graphically. In spite of the doubtful validity of the flow picture given by the pitot tube, it provides considerable evidence in support of the theory that water circulates between impeller blades and guide channels while flowing through the pump. It appears that the peripheral component of velocity of the water is independent of the water discharge and that the general direction of flow inside the channel is always inwards (towards the inner radius). Further, the pump characteristic curves, obeyed to a great extent the laws of dynamic similarity for centrifugal pumps. This strengthens the belief that it should be classified as a centrifugal machine.

## Comparison

Fig. 13 gives the amount of air exhausted by different pumps per second, the amount being expressed in volume of free air at N.T.P. conditions. Further, Fig. 14 gives the volume of free air (as in Fig. 13) expressed as a percentage of the volume of water pumped by the pump per second at its maximum efficiency. Both figures illustrate clearly that the water ring pump far exceeds the two centrifugal pumps in its capacity as a vacuum pump (and consequently in its priming speed). On the other hand, although self-priming attachments involve a certain loss of efficiency for both the centrifugal pumps, their efficiences are much higher when running full than that of the water ring pump. Fig. 15 shows a typical efficiency curve for each pump.

The water ring pump has a limited range of application. It develops relatively high pressures, but pumps a small amount of clean fresh water only. This fact may outweigh to a great extent its advantage for quick priming, but does not diminish its value as an air exhaustion pump.

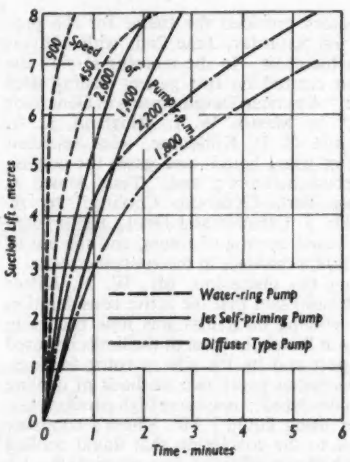



**Fig. 14—Range of time of priming for different pumps**

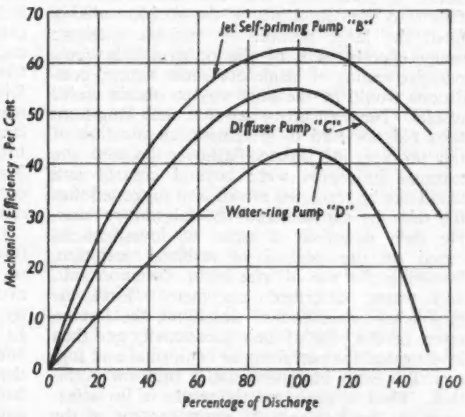
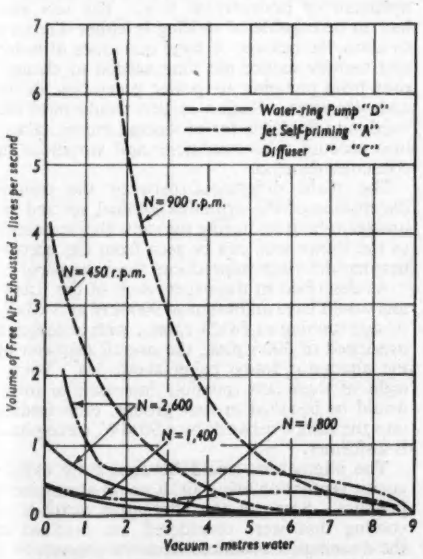



**Fig. 15—Typical efficiency curves for different pumps**



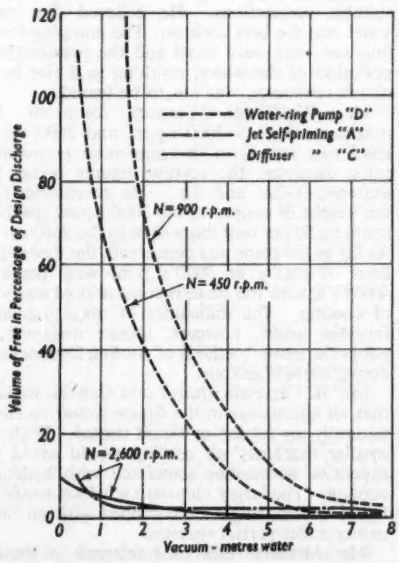


Water-ring Pump "D"
Jet Self-priming "A"
Diffuser " "C"
N = 900 r.p.m.
N = 450 r.p.m.
N = 2,600 r.p.m.
Volume of Free in Percentage of Design Discharge
Vacuum - metres water

**Fig. 13—Comparison between characteristics of different pumps when working as vacuum pumps**

The jet pump proved better than the diffuser pump in its capacity as a vacuum pump, in efficiency during normal running and in attaining a higher value of limiting vacuum. Presumably the water spray in the jet pump is more efficient in transferring the momentum of water to the air than are the circulating streams of water in the diffuser pump. The small number of blades in the rotor of the diffuser pump impeller may, however, be the cause for its low efficiency. The small volume and weight of a diffuser pump makes it more suitable for portable duty than jet pumps, which are heavier and bulkier.

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Institution of Chemical Engineers.—The annual report for 1955 of the Institution of Chemical Engineers notes that membership increased by 145 to a total of 3231 and reviews the position with regard to education and training. A list of the council for 1955–56 is given, the president being Mr. J. A. Oriel and the vice-presidents Messrs. W. Idris Jones, N. E. Rambush, H. L. Roy and P. K. Standring, and there are reports of the various branches at home and abroad. The report records that the Osborne Reynolds medal has been awarded to Mr. F. E. Warner, that Moulton medals were awarded to Messrs. J. S. Forsyth and J. T. Wood, and A. L. Whynes, that Mr. J. D. Howie was awarded the William Macnab medal and that the Hinchley medal was awarded to Mr. E. A. Harvey.

# High-Voltage Power Systems

## C.I.G.R.E. MEETING IN PARIS

No. II—(*Continued from page 673, June 15th*)

*The sixteenth meeting of C.I.G.R.E., the international conference on large high-voltage power systems, was held at the Fondation Berthelot, 28, Rue St. Dominique, Paris, from May 30 to June 9, 1956, and was attended by delegates from forty-three countries. At the opening ceremony the French Minister of Industry presided and the delegates were welcomed by Dr. R. A. Schmidt, president of C.I.G.R.E., who gave a review of the activities of the Conference. The technical sessions began on May 31st. Groups of papers were discussed dealing with alternators, transformers, circuit breakers, high-voltage cables, overhead lines and towers, insulators, protection and relaying, system stability and load and frequency control, and transmission by d.c. and a.c. at extra high voltages. A résumé of the discussions on insulators, alternators, circuit breakers and cables is given here.*

### Insulators

TWO papers were discussed on June 1st in a session devoted to insulators, under the chairmanship of Mr. G. H. Gillam (Great Britain). The first paper, "Testing Insulators with Reproducible Foreign Layers on the Surface," was submitted by H. von Cron, as a contribution to the problem of the introduction of a leakage-flashover test method—"leakage-flashover" being defined for the purpose of this paper as the flashover along an insulator surface under the influence of a foreign layer. The author recalled the failure of earlier attempts to devise a short-time test and attributed this failure to the complexity of the problem arising from the large number of variable factors: many experts were of the opinion that comparative testing of insulators under natural conditions would be the only way to obtain useful results. He went on to say that such long-term tests did not lead to systematic clarification of the problem of leakage-flashover because the external influences were beyond control and could not be regulated at will, and suggested that the tests be supplemented by laboratory tests. He then described a series of investigations based on the method of artificial pollution, involving the use of kieselguhr, common salt, and water, described elsewhere. First, he established a method of classifying the foreign layers on the basis of their conductivity and then investigated the performance of normal and fog-type Langstab insulators under uniform pollution. Then he examined the results of investigations on the influence of water content of the foreign layer, on the partial drying of the layer by surface discharges, on the influence of the diameter of the insulator on its leakage flashover, on the washing effects of rain and, finally, on the influence of extreme non-uniform distribution of the contaminating layer.

Dr J. S. Forrest (Great Britain), who opened the discussion, recalled that more than twenty years ago, when insulators were being designed for the British grid, artificial rain tests proved to be unsatisfactory because the information available on such factors as leakage was scanty. However, the methods described in von Cron's paper could be used to test and compare similar fog-type insulators and strings with cap-and-pin insulators. Dr. Forrest went on to describe and illustrate a surge-current meter for measuring unsteady leakage currents. This instrument embodied three surge counters and a milliammeter, and it could be used to make comparative tests of insulators. It could also be used at appropriate time intervals to determine whether insulators needed cleaning.

Mr. N. Hylten-Cavallius (Sweden) questioned the effectiveness of laboratory tests on artificially polluted insulators, because it was doubtful whether they could give reproducible results. Such tests, however, might provide the manufacturer with a useful comparative guide.

Dr. C. H. W. Clark (Great Britain) expressed the need for finding some correlation between service performance and laboratory tests. One of the major difficulties in laboratory testing was that arbitrary conditions had to be selected; the conditions were necessarily arbitrary because service conditions varied between very wide limits. Fortunately, some of the variables tended to be self-cancelling, so that, for example, if a polluted insulator were partially cleaned, the test result was not grossly affected.

Dr. H. von Cron (Germany), in his reply, asserted that the results obtained from laboratory tests with artificially polluted insulators were quite compatible with those derived from tests with naturally polluted insulators. He agreed that comparative tests, as suggested by Dr. Forrest, would be useful.

### Alternators

Alternators provided the theme for the proceedings on Saturday, June 2nd, with Mr. G. Belfils in the chair. In the morning session the discussion centred on two papers dealing with cooling: "American Developments in Generator Cooling," by Messrs. W. L. Ringland, L. A. Kilgore and C. E. Kilbourne, who described methods of using liquids and gases for cooling large turbo-generators; and "Tests Aimed at Improving Turbo-Generator Cooling," by A. Mandi, Dr. J. Urbanck and Dr. L. Heller, who outlined liquid cooling of rotors, and the use of refrigeration techniques in the coolant circuits.

Opening the discussion, Mr. W. N. Kilner (Great Britain) said that the active consideration of inner cooling of stators was now becoming necessary in Britain because of the limits imposed by transport and by the size of rotor forgings. In the American paper two methods of cooling had been described: one using high-pressure gas, the other using liquid. Mr. Kilner's company had come to the conclusion that liquid cooling gave the better results and was practicable. He wondered, therefore, why the Americans seemed to favour high-pressure gas cooling. The main difficulty with liquid cooling was to devise satisfactory connections for bringing the supply of coolant to and from the high-voltage conductors. Mr. Kilner showed some slides illustrating a method that was being developed for providing suitable connections. He believed that pure water was the best coolant. The pumping losses involved were very small and the possibility of pollution of the water, resulting in a rise in its ohmic resistance, was not to be feared.

Mr. Wolfhugel (France) compared the maximum sizes of 3000 r.p.m. and 3600 r.p.m. machines, based on the maximum permissible rotor diameter, the relative figures being, for example, 1·2m and 1m. He concluded that the weight of copper in the 3000 r.p.m. machine could be 50 per cent more than in the 3600 r.p.m. As far as the rotor was concerned, the theoretical limit of rating at 3000 r.p.m. was, perhaps, 400MVA with the present conventional methods of cooling. The difficulties of obtaining large forgings might, however, induce designers to adopt the newer methods of cooling for machines above 300MW output.

Mr. B. Cerretelli (Italy) said that he foresaw that all alternators in the future would be either naturally air cooled or liquid cooled. With the smaller machines air cooling would avoid the expensive accessories associated with hydrogen cooling. The larger alternators, which would be liquid cooled, might be equipped with an outer casing under partial vacuum.

Mr. Alekseef (U.S.S.R.) referred to the use of hydrogen under pressure for rotor cooling—the system used in his country for all alternators over 200MW. There was some advantage in having a separate system for the rotor and the stator. Such an arrangement, he thought, was perfectly satisfactory for outputs up to 500MW.

Mr. L. W. James (Great Britain) said that the difficulty of transporting single loads of more than 150 tons in Britain, and the corresponding limit imposed on the size of the stator, was the main reason for adopting direct cooling of the stator conductors. Otherwise there was no objection to the design of gas-cooled alternators up to 250MVA. The first British direct-hydrogen-cooled alternator, of 60MW output, went into service in December, 1952, and many other machines with similar cooling had since been commissioned and others were on order. As a result of experimental work done on direct stator cooling, two alternators with liquid-cooled stators and one with a hydrogen-cooled stator were expected to be in service within the next two years.

Mr. R. David (France) said that, with the aim of reducing the size of alternators his company was building a 125MW machine with direct cooling of stator and rotor conductors. It would be about half the size of an alternator of traditional design. Logically, it was better to abstract the heat directly from its source—the conductor—rather than through the insulation.

Mr. Bauldry (U.S.A.), who replied on behalf of the authors of the paper, agreed that gas cooling could be used satisfactorily for alternators up to 500MVA. The cooling of the rotor was more critical than that of the stator. In the U.S.A. a 370MVA set with a 37in diameter inner-cooled rotor had been built and tested and, in all, nine machines up to 320MVA, using inner cooling, were in operation. He thought that, before inner cooling by liquid could be regarded as safe, many problems involving insulation and corona would have to be solved.

Summarising the discussion, the chairman, Mr. Belfils (France), commented on the differences in viewpoint springing from the fact that a 50 c/s, 3000 r.p.m. rotor could be of larger diameter than one of 60 c/s, 3600 r.p.m. Accordingly, a 50 c/s alternator could be built with a correspondingly higher output, without having to resort to special cooling methods. For very large machines liquid cooling seemed to be preferable, bearing in mind efficiency and pumping losses. Mr. Belfils pointed out that in France, mainly because of her inland waterways, the size of alternators was not limited, as it was in Britain by transport restrictions.

*Tidal Power Plant.*—Alternators for the tidal power plant of the Rance were described in a paper by Messrs. R. Gibrat and L. Kammerlocher (France). In the Rance scheme a tidal power station was envisaged, consisting of about forty horizontal generating sets, each comprising an upstream-bulb water-wheel direct-coupled to an alternator. To take full advantage of the tidal regime the water wheels were required to act either as turbines or as pumps with either upstream or downstream flow. The sets also had to be capable of sluicing in either direction to allow the passage of large quantities of water and thereby reduce the time needed to change-over from pumping to power generating duties and vice versa. Such a system would have the maximum flexibility for producing energy, taking into account tidal conditions and variations in consumer demand.

The main differences between the overall dimensions of the orthodox vertical set and an upstream-bulb set having the same characteristics as the Rance sets, can be seen from the accompanying drawings (reproduced from the paper).

As described in the paper, each of the Rance sets would have an output of 9000kW at 5·65kV, 50 c/s, running at 88·23 r.p.m., with a designed overspeed of 300 r.p.m., the overall diameter of the alternator frame being about 5m. Thirty-eight of these sets (possibly increased to forty) would be installed in four groups, each feeding into the 225kV network by a 90MW, three-phase transformer.

The alternators would be cooled by closed-circuit ventilation using air at about atmospheric pressure. Some of the alternative methods of cooling that were considered are outlined in the drawings, reproduced from the paper.

*Insulation of Alternators.*—Two papers provided the basis for the discussion of alternator

insulation. The first, by Messrs. J. Tomiyama, C. Uenosono, S. Hoki and G. Ikeda, described a method of testing the dielectric characteristics of generator windings; the second, by Messrs. J. Fabre, G. Lang, J. Laverlochère, G. Leroy, J. Narcy and G. Ruelle (France), gave details of research work on large synchronous machines.

Opening the discussion, Mr. Hess (Switzerland) emphasised the difficulty of trying to adopt constants for the various classes of insulation and he pointed out that temperature had a very important influence on insulation characteristics. In applying the tests recommended by the French authors it was very important to make a careful visual inspection of the winding insulation and to correlate these observations with the measurements made.

Monsieur Narcy (France), one of the authors, agreed that the general condition of the winding had to be taken into account. Their paper suggested criteria which could be useful as a warning but were not intended to give specific information about the locality of a fault. Progressive deterioration might be identifiable by thermal testing.

Mr. T. V. Stromberg (Sweden) quoted from his experience with alternators which had operated for long periods with a high temperature difference between the temperature sensitive element and the copper without noticeable deterioration of the insulation.

The user's interest in old plant as well as new was mentioned by Mr. R. H. Coates (Great Britain), who pointed out that, in Britain, 40 per cent of the generating plant was more than eleven years old and 30 per cent more than eighteen years old. Discussing methods of winding-temperature measurement, Mr. Coates commented on discrepancies in the temperature difference between the copper and the sensitive element when comparing machines of similar size, design and age. Such discrepancies could be noted in a table in the French paper and could be matched from his own experience. He thought that the existence of a temperature difference was not by itself significant provided that the difference did not vary appreciably with the age of the machine.

Monsieur G. Leroy (France), who replied to the discussion, agreed with Mr. Coates that temperature differences could only be usefully compared on similar machines. He said that it was proposed to repeat those insulation tests on certain machines at intervals of five years, so that a useful history of the machines might be compiled.

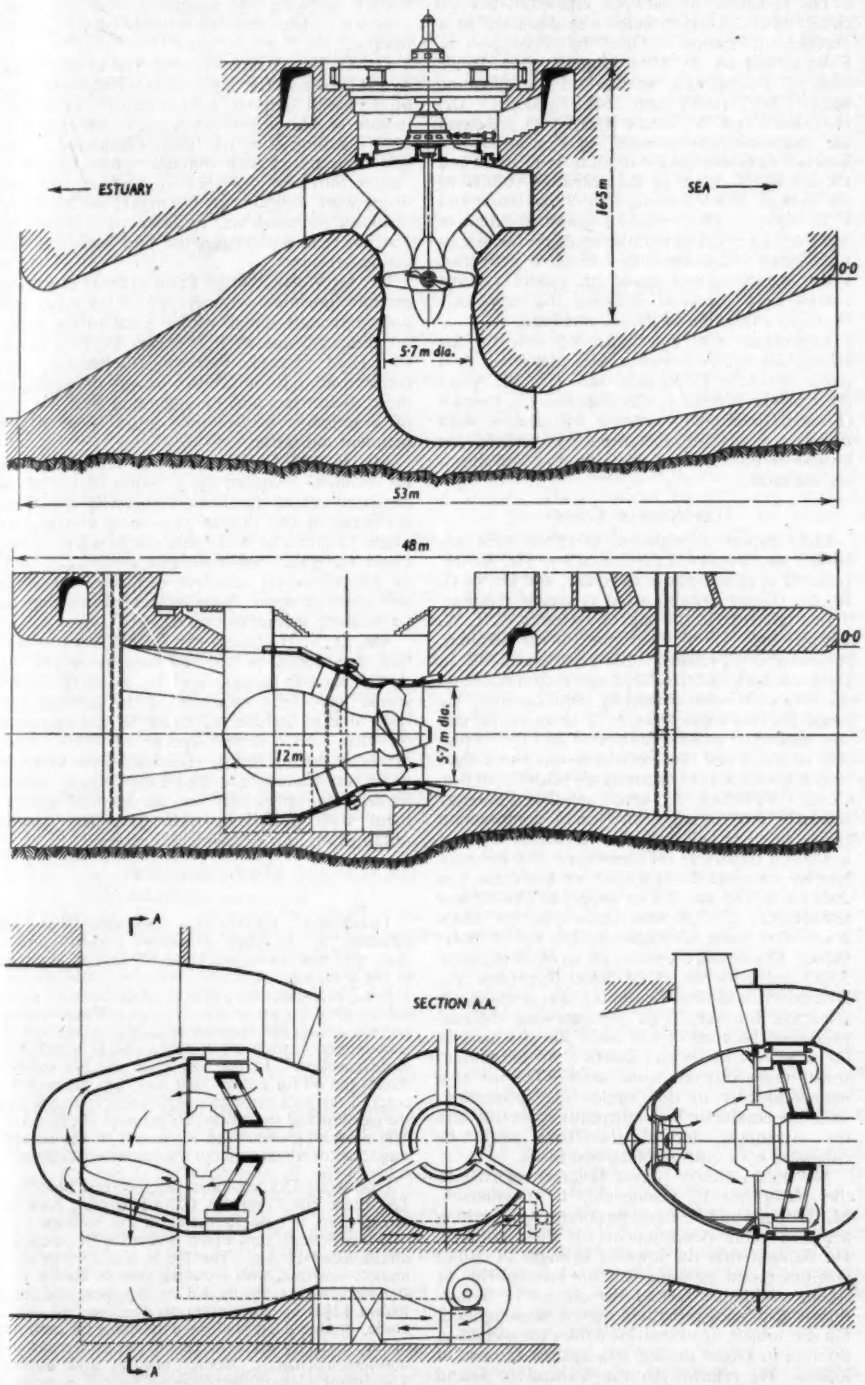
*Measurements on Alternators in Service.*—Three papers provided the main topics for discussion under this heading. Mr. E. B. Powell (Great Britain) described a stroboscopic method for diagnosing alternator performance and indicated its scope. Mr. D. T. Bath (Canada) dealt with a digital electronic system for deceleration measurements in retardation tests on water-wheel alternators. Messrs. E. W. Connon and and S. J. Morley (Great Britain) discussed the measurement of alternator temperature rises in service. The authors of this third paper recalled that the cost of generating plant installed to-day was about £60 per kW, and that if one extra megawatt could be obtained from a generator on peak then a capital saving of about £60,000 would be made. Considerable advantages could, therefore accrue from the extended use of temperature indicators for the loading of alternators instead of retaining those indicators merely as protective measures.

Dr. E. Friedlander (Great Britain), who opened the discussion, commented on the useful information obtained from phase angle measurements. Referring to the measurement of winding temperatures, he outlined the advantage gained by the establishment of formulæ for calculating the difference between the temperature of the conductor and that of the sensitive element.

Mr. J. L. Egginton (Great Britain) described an interesting alternative to the stroboscopic method of measuring the phase angle. His system, which had been installed in Portobello power station, Edinburgh, consisted essentially of a power-factor meter scaled in electrical degrees and mounted on a panel in the control room. A red mark on the dial indicated the stability limit.

Monsieur Favez (France) referred to a system which was based on measurement of phase angle and facilitated stabilisation of turbo-generators when operating in an under-excited condition.

Mr. T. V. Stromberg (Sweden) said that accurate information about the stator temperature was important. In Sweden the temperatures recorded by the measuring elements were sometimes corrected to allow for the temperature drop across the thickness of the insulation. Referring to Mr. Bath's paper, he said that retardation tests had been successfully applied to slow-speed water-wheel alternators.




**Alternators for the Rance tidal power scheme. The two upper drawings compare the overall dimensions of the orthodox vertical set and an equivalent upstream bulb set. Alternative cooling systems are shown in the lower drawings**

## Circuit Breakers

Eighteen papers dealing with circuit breakers were discussed in the session held on Monday, June 4th, under the chairmanship of Mr. H. Schiller (Switzerland).

Mr. A. R. Blandford (Great Britain), who opened the discussion, was the first of a number of speakers to comment on the special report by Mr. H. Schiller on the work of the study committee on circuit breakers. Mr. Blandford began by outlining some of the difficulties involved in attempting to set up standards of natural frequencies. Suggested values for natural frequencies as a function of voltage had been proposed in various countries, including France, Sweden and Switzerland, and the values were lower than those favoured by the British. On the British network the natural frequency was inherently higher because very large blocks of power were transmitted over very short distances. Mr. Blandford expressed surprise at the attempt to specify a standard, since the natural frequency was a characteristic of each individual power system and its value would vary between one system and the next. Because of this variation the same circuit breaker might in practice be offered with a rating of, say, 3500MVA on continental systems and perhaps 2500MVA on

the British system with its higher natural frequency. Accordingly, he thought that it would be more useful to establish a range of ratings for a particular kind of switch showing its rupturing capacity at various natural frequencies rather than to try to set up standards of natural frequency.

On the same topic Mr. H. Leyburn (Great Britain) said that the report of the study committee on circuit breakers appeared to be based on the assumption that the local short-circuit capacity was 100 per cent of the total possible short circuit capacity. In Britain, however, the value was only about 60 per cent and he therefore suggested that a study should be made of the natural frequencies of systems at MVA values below 100 per cent. If a natural frequency standard was possible at all (and he personally doubted whether it was) it should be based on a reasonably wide range of MVA values (per cent) rather than on a single value of 100 per cent.

Mr. Maggi (Italy) stated that the power system operators generally knew little about the network characteristics at the time when they had to order their switchgear and they did not always have access to the network analysers which would give the required solution.

Three papers on arc behaviour in circuit breakers were then discussed. In these papers Dr. H. Edels and F. W. Crawford (Great Britain) described the determination of the free recovery of gaps after arc interruption ; Messrs. A. M. Cassie and F. O. Mason dealt with post-arc conductivity in gas-blast circuit breakers, and Dr. J. ter Horst and G. A. W. Rutgers (Netherlands) discussed current-zero phenomena in a.c. arcs in air-blast circuit breakers.

Commenting on the phenomenon of post-zero conductivity, Mr. A. F. B. Young (Great Britain), who opened the discussion, said that it was difficult to measure arc conductivity after the instant of current zero because of the very wide range of current values involved. In measuring currents down to zero one difficulty was the self-inductance of the shunts which could give a false indication of post-zero conductivity even where it did not exist. It would be better to use mutual inductance provided by open circuited current transformers to measure the rate of change of current.

Another method of measuring post-zero arc currents was described by Mr. J. V. Byrne (Eire), who outlined some experimental work in which the magnetic field associated with the arc current was used to produce direct electromagnetic deflection of the beam in a cathode-ray tube.

Mr. H. Thommen (Switzerland) showed slides relating to tests of post-arc currents in three circuit breakers—a bulk-oil breaker, a low-oil-content breaker, and an air-blast breaker. For those equipments the post-arc currents were found to be in descending order. From the tests it could be concluded that the value of the post-arc current depended not only on the design of the circuit breaker, but on the natural frequency of the system and on the value of the current interrupted.

Mr. W. Rieder (Austria) said that from his work on arc extinction it was evident that Ohm's law could not be applied to the post-arc current regime. He showed a slide summarising the effect of gap length on rate of rise of restriking voltage and said that he had found it possible to extinguish an arc by reducing the contact separation.

In a supplementary contribution to his paper Dr. Edels (Great Britain) described an interesting method of using shock waves as a means of deducing the gas temperature in an arc. A shock wave was introduced transversely across the arc gap. By the Schieren effect variations in luminosity were produced by the entry of the shock wave into the gap. The progress of the wave across the gap was recorded cinematographically with the help of a rotating mirror drum. From this record it was possible to deduce the gas temperatures across the arc and the decay in temperature.

A group of papers on circuit breakers was then discussed. It included a report of recent work on minimum-oil circuit breakers, by Messrs. E. Vogelsanger and P. Joss (Switzerland); current progress in air-blast circuit breakers by H. Thommen (Switzerland) ; a description of a new circuit breaker designed to meet Canadian requirements, by Messrs. J. P. Skillen and D. H. McKeough (Canada), and an account of magnetic blast in circuit breakers, by Messrs. W. Rieder and A. Eidinger (Austria).

Dealing with the subject of small-oil-volume circuit breakers, Mr. R. W. Buttrey (Great Britain) referred to the use of axial blast with side orifices to provide vent outlets only.

Mr. D. F. Amer (Great Britain) outlined some results of tests made on 132kV switchgear with laterally vented arcing chambers, at a testing station having a single-phase output of 1600 MVA. Those tests indicated that the current that could be broken consistently was inversely proportional to the recovery voltage.

In reply to an earlier speaker, Mr. E. Vogelsanger (Switzerland) gave typical oil quantities for small volume oil circuit breakers as 100 litres at 60kV and 300 to 400 litres at 220kV. He went on to say that he disagreed with Mr. Amer's statement that the current broken varied inversely as the voltage.

The influence of network characteristics on circuit breaker performance was discussed in a number of papers. One, by Professor S. Fukuda and Dr. F. Mori (Japan), gave details relating to restriking voltage on the Japanese 66kV, 77kV, 110kV and 154kV systems. Dr. H. Dorsch and W. Schick (Germany) presented the results of measurements made on a network analyser to determine the natural frequencies and the amplitude factor of the restriking voltage of the R.W.E. 220kV system. Dr. J. ter Horst and F. S. Bertrums (Netherlands) described extensive work on the effect of parallel loads on the amplitude factor of the restriking voltage of networks. From measurements made on model systems curves were prepared showing the amplitude factor as a function of the parallel load.

Experience with automatic reclosure on the Hungarian 120kV network was described in a paper by Mr. T. Bendes and Dr. M. Vajta (Hungary). Messrs. L. Cabanes and Ch. Dietsch (France) described a scheme for dealing with transient faults in substations by earthing the busbar on both sides of the faulty line and shunting the fault.

### High-Voltage Cables

Eight papers on high-voltage cables were discussed on Tuesday, June 5th, when Mr. M. M. Laborde (France) was in the chair, and Dr. L. G. Brazier (Great Britain) acted as special reporter.

In a reference to the paper by Messrs. C. T. W. Sutton and A. M. Morgan (Great Britain), reviewing compression cable experience, Mr. L. Domenach (France) offered some comments on the subject of voids caused by rapid cooling. He suggested that a gas pressure of 15 kg per sq. cm. was needed to prevent ionisation and the formation of voids and that polythene was better than lead as a sheath for temperatures below −10 deg. Cent. Referring to tests at the Fontenay research and testing centre on a compression cable, he asserted that the resistance of thin insulation papers to oil movement was not prohibitive. Eventual breakdown of the cable was due, not to the use of thin paper, but to the low temperature of −20 deg. Cent. and the failure could have been prevented by the use of polythene. Discussing the paper on an all-aluminium 301kV cable by Mr. H. D. Short (Canada), Mr. Domenach said that aluminium was particularly attractive for very high voltages and internal pressures, because of the need for channels in the core and under the sheath : an aluminium sheath made this provision easier. The use of a segmental core in this cable was interesting, since the conductor was inherently smoother and the advantage derived therefrom could be enhanced by a coating of carbon black.

Mr. E. L. Davey (Great Britain) referred to the paper by P. Capdeville, L. Domenach, M. Heupgen and R. Laroche (France), describing pressure cable developments in their country. He thought that the impulse strength of cables was not raised by using sulphur hexafluoride or freon. With the former the danger of hydrofluoric acid being generated should be recognised. On the subject of submarine cables the weight of opinion in Great Britain was against the use of joints. He referred to the Vancouver Island crossing, which would be made by 16-mile lengths of jointless cable to be laid later in the year.

Dr. K. H. Hahne (Germany) discussed the main disadvantage of aluminium sheath on a three-core cable—its high conductivity. One method of overcoming this defect was to produce a single sheath around the three cores. He showed a slide illustrating a three-core 110kV cable surrounded by an aluminium sheath with circumferential corrugations. Between successive corrugations the sheath was cylindrical and in contact with the cores. In a given length of cable the corrugated portions accounted for one-third of the sheath length and the intervening cylindrical portions two-thirds of the length. The sheath had a wall thickness of 0·1in and was protected by a p.v.c. coating.

Mr. R. J. Wiseman (U.S.A.) said that he did not know of any self-contained gas pressure cables in the U.S.A. but there was some piped gas pressure cable. Referring to the paper by Messrs. Sutton and Morgan, he believed that the impulse strength did depend on the gas pressure. Commenting on the paper by the French authors, he suggested that the high pressure cable was particularly deserving of interest.

Dr. G. Buss (Germany) referred to the paper by P. Gazzana-Priaroggia and G. Palandri (Italy) on the use of synthetic casting resins in the manufacture of e.h.v. cable accessories. He said that 220kV sealing ends for plastics-insulated cables had been tested with impulse values of 500kV before flashover. Flashover voltages of that order were desirable in Germany, where heavy insulator pollution was experienced in industrial districts ; in some cases use had been made of condenser cones.

Dr. G. Weissenberger (Switzerland) expressed general agreement with the results for p.v.c. and polyethylene-insulated cables given in the paper on plastics-insulated h.v. cables by O. Gasser, Ch. Held and H. Pairitsch (Germany). He emphasised that ionisation was very damaging to these dielectrics, and he suggested that the use of a sensitive bridge was desirable to detect incipient ionisation.

Mr. R. C. Mildner (Great Britain) said that his company favoured the criterion that plastics-insulated cables should be completely free from discharge at the normal operating voltage. It might be possible to be less conservative if one could recognise non-malignant discharges, such as pin-points, by sensitive means of detection and measurement. Such considerations applied particularly to high voltage d.c. working.

Mr. D. T. Hollingsworth (Great Britain) said that the value of the informative paper by P. Gazzana-Priaroggia and G. Palandri (Italy) would have been enhanced if the authors had been able to include the effect of heating cycles on the e.h.v. cable accessories made from synthetic casting resins. Discussing the German paper on plastics-insulated high-voltage cables, he said that uniformity was an essential requirement with polythene. He gave test results obtained on four experimental cables.

(*To be continued*)

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Two-Stage Catalytic Cracker.—We are informed by the Shell Petroleum Company, Ltd., that the new two-stage catalytic cracker installed at the company's Anacortes refinery in Washington, U.S.A., increases the yield of gasoline from crude oil by amounts up to 15 per cent. The two-stage process avoids the overcracking and undercracking encountered in ordinary cracking and thus produces more gasoline. In the first stage the hot catalyst strikes the oil for a short time and then the partially cracked oil goes through a separating system where the gasoline and gas formed at that stage are removed. The remaining uncracked oil passes to the second-stage reactor which employs the conventional process.

File with Double-Sided Renewable Blades.—The Tresa File Company, Oxford Airport, Kedlington, Oxford, is now marketing in this country a file of Swiss manufacture which is fitted with renewable double-sided blades. The file is available in three models—narrow, with a cutting area of 9in by ¼in ; standard, with a 9in by 1in cutting area, and long, with a 12½in by 1in cutting area. Fine and coarse grade, double-sided blades are available for each size of file, and they are suitable for use on ferrous and non-ferrous metals, wood, plastics and rubber. The cutting edges of the blades are formed by inclined slots across the width, and the material removed in filing passes back through the slots so that there is no clogging of the teeth.

# Fifth World Power Conference

## No. I

*The fifth World Power Conference, held this week in Vienna, included contributions to all aspects of the technologies of fuel and power. An outline of the scope of the conference is given here, followed by notes reviewing the papers on statistical questions and on solid and liquid fuels.*

DURING this week, the fifth World Power Congress has been taking place in Vienna. The last of the technical sessions of the congress are to be held to-day and tomorrow, and many of the participants will then be going on post-congress tours of engineering centres in Austria and in neighbouring countries. The fifth congress is the second to be held since the war ; its predecessor was the one held in London in 1950. There have also been three sectional meetings since the war, at The Hague in 1947, New Delhi in 1951, and Rio de Janeiro in 1954.

Several hundred papers are being discussed at the fifth congress, the scope of which is very wide, covering all aspects of the natural resources and technologies of that fundamental need of all engineering development, the utilisation of power. Thus, natural fuel resources and their utilisation, power generation, and so on, are all dealt with. The papers and discussions have been classified according to the following list :—

Division I : The present status and development of power production and utilisation in individual countries.
- Section A : Statement and statistical review during the period 1950 to 1954 (forty-two papers).
- Section B : Methods of compilation and use of statistics (sixteen papers).

Division II : The preparation and conversion of fuels.
- Section C : The preparation and conversion of solid fuels (twelve papers).
- Section D : The liquefaction of solid fuels—the preparation and treatment of liquid fuels (nine papers).
- Section E : Gasification of fuels—the preparation and treatment of gaseous fuels (twenty-four papers).
- Section F : Economic and technical requirements for the establishment and operation of long-distance gas supply systems (ten papers).

Division III : Utilisation of primary sources of energy.
- Section $G_1$ : Thermal plants : planning of the entire plants (twenty-eight papers).
- Section $G_2$ : Thermal plants : problems concerning the construction and operation of steam boilers (twenty-three papers).
- Section $G_3$ : Thermal power plants : technical problems of the mechanical equipment (eleven papers).
- Section $H_1$ : Hydro-electric plants : planning of the entire plants (forty-five papers in $H_1$ and $H_2$).
- Section $H_2$ : Hydro-electric plants : technical problems of the mechanical equipment and construction questions.
- Section $J_1$ : Atomic energy : reactor technology (nineteen papers in $J_1$ and $J_2$).
- Section $J_2$ : Atomic energy : raw materials, profitability, auxiliary plants.
- Section K : Other sources of energy and special processes for their utilisation (eleven papers).

Division IV : Purification of waste water and exhaust gas in the production and use of energy.
- Section L : Purification of waste water in the production of energy (three papers).
- Section M : Purification of waste gas in the production of energy (five papers).

Division V : International co-operation in the production and use of energy.
- Section N : Technical aspects of international co-operation in the production and use of energy (nine papers).
- Section O : Economic aspects of international co-operation in the production and use of energy (eight papers).

A general report, reviewing the constituent papers, is published for each of the sections listed above. All the general reports are printed in all three of the congress languages—English, French and German—but the individual papers are published only in one language.

A great deal of first-rate engineering knowledge is displayed in the vast body of technical literature—papers and general reports—resulting from the congress. It would be beyond our scope to give a comprehensive review in these columns, of all that it contains, with reasonable timeliness and brevity, for the best of contemporary practice and trends, and some of the most striking technical innovations, which each of the participating countries can demonstrate, is to be found in these papers. However, in the following account we have picked out some of the conference topics which appear to be of special interest. In some cases abstracts from the general reports are given, and in others information or abstracts have been taken from some of the papers of the section concerned, or from the discussions at the conference. The references in brackets which occur here and there refer to the conference classification of the papers concerned.

### National Power Economies

The fuel and power economies of many countries of the world are set out in the papers of the two sections of Division I. In some cases the statistical outline presented serves only to show the changes which have occurred since the fourth world power conference in 1950 ; in other cases a complete account is given of a country's achievements and consumption, or of one particular aspect of it, such as hydro-electric power. These reviews are primarily statistical, but give valuable information on trends of national development. Broadly speaking, an increase in energy demand is apparent, but it is not evenly distributed over individual sources of energy.

The general report for section " A " summarises the various national surveys according to energy resources and points out world trends in the use of solid fuels (coal and lignite, peat, and wood), liquid and gaseous fuels (petroleum, shale oil and natural gas), water power and electricity, and " other sources of energy." The last named includes atomic energy, solar energy, terrestrial heat, tidal power, wind power, energy from sewage sludge, and vegetation. The general report also makes some remarks on the organisation and finance of the fuel and power industries af the various countries.

There has been some difficulty in comparing the statistics from different countries, and the development of a uniform method of expressing statistical data is suggested. The general report of section " B " also suggests the following points for discussion : closer collaboration between statisticians and hydrologists ; further standardisation of water power surveys ; applying recent probability theory to forecasts of fuel and power demands ; increased sample surveys amongst consumers ; the preparation of data in a form more suitable for forecasting ; and a clear definition of terms such as " probable energy reserves."

All the papers in section " A " are national reviews of one kind or another, except for two papers by British authors relating to oil resources, to the international fuel and power scene. Section " B " demonstrates an increasing use of statistical methods ; estimation of hydro-electric resources and forecasting load demands illustrate two aspects of this work. As noted above, improved and standardised methods of presenting statistical data are considered essential by several authors. Various advances in applying statistical techniques are suggested, and there are also papers commenting on world energy statistics.

The papers in Division I do not lend themselves readily to any form of brief presentation of their contents ; for fuller information we would refer readers to the original papers themselves.

### Solid Fuels

There are a dozen papers on the preparation and conversion of solid fuels in section " C." Some countries are experiencing a deterioration in quality of run-of-mine coal, and consequently are using modified processes to extend, for instance, the range of coals suitable for coking. The ways in which such problems can be overcome is one of the topics suggested for discussion in the general report ; it is also asked to what extent coal mining has been mechanised, and in what manner the raw coal is affected by mechanisation as applied up to the present.

A German paper on coal preparation and utilisation (89 C/5) points out that post-war reconstruction in that country has resulted in a genuine rationalisation of the industry. In the treatment of by-products, in chemical upgrading, in combustion technique, and in gasification, new developments are noted. Opencast mining of brown coal in Germany is reviewed in paper 189 C/12, and the large rotary excavators and other equipment used for German opencast mining and the way the mines are laid out and worked are discussed.

An interesting British development is the increasing use of pulverised coal in power stations ; 19,000,000 tons of pulverised fuel were used in 1954, and there is prospect of 37,000,000 tons being consumed in 1960 (paper 116 C/8). Some further comments on the section " C " papers, taken from the general report (written by Professor E. Bierbrauer) are given under the following two sideheadings.

*Preparation.*—Preparation in the strict sense of the word covers the mechanical removal of inert materials contained in the raw coal and grading into sizes suitable for sale. Thus, preparation is the connecting link between the mine and the consumer and, therefore, is affected by any changes taking place either in coal production or on the coal market. In both these fields, developments have started which have caused preparation to assume a key position. The quality of the coal produced has deteriorated owing to the fact that mining methods have been intensified and mechanised to a very large degree. Selective mining has been abandoned with the result that the ash content of run-of-mine coal has increased as well as the output of small coal, since the raw coal is now exposed to heavier stresses while being mined and loaded. Paper 89 C/5 proves that in the Federal Republic of Germany—as well as in other European countries—refuse in the hard coal mines rose from 12·9 per cent of gross production in 1936 to 23·9 per cent in late 1954. These changes, partly caused by the rationalisation of mining, involve new preparation problems which some of the old plants are no longer able to cope with. As regards the coal market, this is affected by another circumstance : coal has ceased to be the only source of power available, it must now compete with fuel oil, natural gas and water power, which are easier to handle and more adaptable.

Coal cleaning is fundamentally affected by these changes. The aim to be achieved is to produce at low cost and with a minimum of loss, high-grade coal from run-of-mine coal that has deteriorated in quality for the reasons shown above. Most of the coal mines in Western Europe are faced with this same problem, solution of which is the more difficult since the expenditure involved must be kept as low as possible. The two German papers, 89 C/5 and 90 C/6, give a graphic account of the current situation. The same difficulties are encountered in all coal-producing countries in Western Europe, where geological conditions are similar. It is remarkable that, judging from reports submitted by non-European countries (19 C/2—Japan), the situation is pretty much the same there, too. Perhaps a single exception is the United States with its rich deposits favoured by unusual geological advantages for mining and preparation.

The general development of coal cleaning is marked by replacing hand-picking by the far less expensive mechanical separation. In this

respect things have changed basically, for up to only a few years ago it was the general practice to hand-pick the coarse size and to use mechanical preparation only for coal less than 80mm in diameter. In some plants, hand-picking is retained for coal sizes exceeding 150mm or 200mm, and decreasing demand for sizes over 200mm promotes full mechanisation. More and more cleaning plants are going over to breaking up the largest lumps to 200mm and to washing these together with the natural lump sizes of raw coal under 200mm.

In recent years, the practice of mechanical cleaning has been gradually extended also to brown coal. Bright brown coal, closely related to bituminous coal, had for a long time been a model of mechanical upgrading. An innovation in this field is the heavy-liquid separation of lignite, such as has been applied in Yugoslavia (184 C/11). Paper 136 C/10, on the establishment of a brown-coal dense-medium washing in the Komorany district in North Bohemia, shows up the difficulties of washing brown coal resulting from the high clay content of the raw coal and proves that the experience gained in bituminous-coal preparation cannot be applied to brown coal without careful previous investigation of all the factors concerned. As a rule, preparation of lignite is confined to sizes greater than 10mm or 20mm, in accordance with economic considerations.

*Briquetting and Drying.*—Considering the increasing demand for quality in solid fuels caused by growing competition, the shape of coal becomes another important factor. Briquetting, therefore, plays to-day a greater role than hitherto. Coal briquettes are always produced with coal-tar pitch as a binder. The foremost problem to be solved in this field and at present the subject of extensive investigations, is to reduce the pitch consumption, usually 6 to 7 per cent. Numerous efforts have been made to achieve an appreciable reduction of this figure ; the use of aqueous pitch emulsions appears to be the most promising, a procedure which is still in its experimental stage.

In Japan, briquettes of coal and brown coal blended are produced, requiring up to 13 per cent of pitch (19 C/2) ; strong efforts at economy are being made there, too. It is interesting to know that briquettes have recently been manufactured in Japan from semi-coke, with sulphite liquor as a binder. Although utilisation of this waste liquor for briquetting has long been known, there is little information about the commercial application of this binder.

In Great Britain, thermal treatment of coal briquettes produced with pitch was introduced some time ago to supply a smokeless fuel which, under the name of " Phurnacite," has gained great popularity among British householders.

The old problem of a smokeless fuel which is of primary importance for the British coal industry has recently acquired a new urgency since in the next ten or fifteen years the task is to replace 19,000,000 tons of the bituminous coal consumed in the densely populated areas by solid smokeless fuel, gas and electricity. Since it is assumed that this change-over will have to be based primarily on supplies of solid smokeless fuel, British coal research is much concerned with trying to solve the problem of how to produce such fuel (paper 117 C/9). Several methods have been developed whereby smokeless briquettes can be produced from coal of lower rank. This coal has to be used, because coal with a low volatile matter content is becoming scarce. Unlike " Phurnacite," which is made from smokeless coal, the basic material of the new fuel must first be carbonised and the briquettes made of semi-coke with pitch subjected to yet further thermal treatment. Research has been directed in the first place to fluidised carbonisation, while thermal treatment of the briquettes will be achieved by using hot sand in a fluid or mobile bed as the heating medium. This direct heating method has the advantage over that applied in the production of " Phurnacite " when briquettes are heated in retorts, of ensuring continuous operation and a very rapid transfer of heat. By blending the pitch with certain substances it is possible to alter the binding power to such an extent that even briquettes of uncarbonised coal with a high volatile content can stand carbonisation without distortion or fusion. A third method provides for the coal being briquetted without a binder and the briquettes being subjected to carbonisation. The paper referred to points out briefly that in the course of these experiments a new form of press was developed which is expected to make the briquetting of practically any kind of coal possible, without a binder. Somewhat surprising is the remark that with this new method a pressure will suffice which is much lower than that used in Germany to briquette earthy brown coal without binders. It follows from this that the new press will be able to briquette bituminous coal, too, by applying a pressure of less than 1200 kg per square centimetre, and without requiring binders. The experience gained hitherto all proves that a very much higher pressure is necessary, which entails difficulties in the operation of the press as well as complicated and costly forms of construction. Some time ago experiments with the " ten Bosch " press (5000 kg per square centimetre) were done by the German coal industry. Some possibility of briquetting bituminous coal without a binder under a low pressure is offered by the various thermo-plastic procedures. However, judging by experiments done hitherto, the hot-briquetting method can—at least in its present stage—be applied to only a very few coals.

It would be highly desirable were the experiments now being made with the new press to be successfully concluded within the near future so that the experts interested in this development could be informed in greater detail. There is no doubt that we have here a revolutionary innovation which is bound to have a tremendous influence on future up-grading techniques.

## Liquid Fuels

In spite of the great expansion in oil refining and oil consumption, only nine papers are to be found in section D of the conference. There are four surveys of national development, covering the United Kingdom, the United States Western Germany, and Japan. Problems in utilising the Hungarian oil recently found at Nagylengyel are discussed.

Oil refinery development in the different countries has been influenced by the pattern of consumption. It is pointed out in paper 127 D/3 that in the United States the aim is to maximise gasoline production and produce large volumes of heating oil, of which a large part is cracked distillate, and, on the other hand, to minimise the production of the lowest priced product, residual fuel oil ; by contrast in the United Kingdom, minimum gasoline production is often the aim, and the demand is for the maximum of saleable middle distillates, and for fuel oil. The following abstract relates to recent trends in the United States in catalytic refining and hydrogen treating, and is taken from paper 174 D/5, " Preparation and Treatment of Liquid Fuels," by Mr. E. D. Reeves.

*Catalytic Reforming.*—Developments in catalytic reforming have been perhaps the most significant of those that have occurred since 1950 in the field of petroleum fuels processing in the United States. This process is used to increase gasoline octane number ; it is not a producer of gasoline. Thermal reforming is an available process for octane improvement, but it has serious limitations. The importance of catalytic reforming stems from its ability to produce yields of the high-octane gasolines needed by the more efficient, high compression ratio automobile engines. A second factor of great importance in catalytic reforming is the cheap by-product hydrogen made in the process. This has reawakened interest in hydrogenation as a petroleum refining operation. The importance of catalytic reforming goes beyond fuels preparation, since the process is basically an aromatics and hydrogen producer and, as such, possesses the potential to supply the basic materials for chemicals manufacture. Growth of catalytic reforming for motor gasoline production has been exceedingly rapid. This growth is shown in Table I.

It has been estimated that the process will expand to a capacity of 900 to 950 MBPD by the end of 1956. By contrast, catalytic cracking capacity did not attain a million barrel capacity until about ten years after the initial installations. Estimates for continued growth of catalytic reforming vary, but it appears that the capacity may about double in the next five years.

Feed stocks for catalytic reforming can be virgin or cracked naphthas. The reforming process produces a stable, high-octane gasoline by dehydrogenation and dehydro-isomerisation

Table I.—*Growth of United States Catalytic Reforming Capacity*, 1950–55

| Year | Capacity, MBPD |
|---|---|
| 1955 | 569 |
| 1954 | 249 |
| 1953 | 198 |
| 1952 | 31 |
| 1951 | 33 |
| 1950 | 32 |

of naphthenes and by cyclisation and dehydrogenation of paraffins to form aromatics. Isomerisation and cracking of paraffins also occur and olefin saturation takes place. Two major catalytic reforming processes are at present used. These are the fluid bed process which employs a powdered molybdena-alumina catalyst and a fixed bed process which uses as catalyst platinum (<1 per cent Pt) on a pelleted support. The bulk of the catalytic reforming capacity now installed uses the fixed bed platinum catalyst process.

Carbon deposition on the catalyst can occur during reforming and reduces catalyst activity. Various techniques are used to combat this. The fluid bed process utilises a regenerator which continuously burns off the carbon. Fixed bed platinum processes divide into two general classes depending upon the method of activity maintenance. Non-regenerative processes normally operate at 500 lb to 700 lb per square inch, and the high hydrogen partial pressure minimises carbon laydown and maintains activity. Catalyst life may be three months or longer. Regenerative processes operate at 200 lb to 400 lb and lower hydrogen partial pressure, and catalyst activity is restored by burning with air.

Application of precious metal catalysts to catalytic reforming was a significant development in the oil refining industry. The platinum catalysts are expensive. New catalyst ranges in price from 8 dollars to 14 dollars per pound. However, all but about 4 dollars of this can be recovered by reworking the catalyst for platinum recovery. All platinum catalysts are susceptible to " poisoning " by various contaminants, but vary in their sensitivity to these materials. Sulphur is a major contaminant and feed desulphurisation is generally necessary. Water and metals, such as arsenic, are also catalyst contaminants. The molybdena-alumina catalysts are insensitive to feed contaminants, and they maintain their activity on high-sulphur stocks. Cracked stocks may be reformed directly on these non-precious metal catalysts without need for feed pretreatment.

Catalytic reforming produces high-octane gasoline, but the key of the process is the dual achievement of high octane at high gasoline yield. This is illustrated in Table II, which com-

Table II.—*Catalytic and Thermal Reforming of Light Virgin Naphtha*

| Feed stock : Gravity, deg. API | | 60·1 | |
|---|---|---|---|
| Boiling range, deg. Fah.: | | | |
| Initial | | 165 | |
| Final | | 280 | |
| Reforming type | Thermal | Non-regenerative platinum | |
| F-1 octane+3cc. TEL | 95·3 | | |
| Product yields : | | | |
| Hydrogen, Wt. per cent | 0·1 | | 1·8 |
| Dry gas, Wt. per cent | 21·8 | | 5·8 |
| Total $C_4$, Vol., per cent | 13·3 | | 3·6 |
| $C_5$/430 deg. Fah., Vol., per cent | 60·8 | | 88·0 |
| 430 deg. Fah.+cycle Vol. per cent | 3·6 | | Neg. |
| $C_5$/430 deg. Fah. quality : | | | |
| F-2 octane+3cc. TEL | 83·3 | | 87·9 |
| Reid vapour pressure, lb per square inch, absolute | 4·2 | | 3·8 |

pares catalytic reforming with the previously available process on a Canadian light virgin naphtha. The thermal results are from a commercial plant test, and the catalytic results are from pilot unit operations on the same feed stock.

For the same F-1 leaded octane number, catalytic reforming produces appreciably more gasoline having a higher F-2 leaded octane. The increased gasoline yield is obtained through reduced yields of dry gas and $C_4$ material.

To increase the octane building potential of catalytic reforming, modifications to the basic process have been developed which provide

further aromatisation of the non-aromatic portion of the basic reformate. A ceiling for conversion of these materials exists, since their rate of aromatisation decreases during reforming due to the increasing concentration of aromatics. The basic methods suggested for increasing aromatisation are :—

(*a*) Separation of a non-aromatic fraction from the reformate by use of solvent or distillation extraction or solid adsorbents and return of this material to the reformer along with fresh feed or to a second reformer which processes only the separated reformate fraction ; or

(*b*) Thermal reforming of the total catalytic reformate which leaves the reformate aromatics relatively unchanged.

These processes can produce naphthas having F-1 unleaded octane numbers greater than 100. There are as yet no operating commercial installations of these processes. Development of these combination catalytic reforming processes will continue as they offer promise as powerful tools to meet future octane number requirements.

*Hydrogen Treating.*—Catalytic hydrogenation as a means for upgrading petroleum fractions has been recognised for many years, but high investments for high-pressure equipment and hydrogen producing facilities precluded its general use. A new interest has developed due to the advent of catalytic reforming, which is a source of cheap, available hydrogen, and the need for a fuel finishing process more efficient and less costly than acid treating.

Catalytic hydrogenation processes as applied to petroleum fuels are, broadly, treating operations. They differ mainly from the older processes in being milder operations. Pressures, for example, are in the range of 50 lb to 800 lb per square inch as contrasted to a range of 1500 lb to 10,000 lb previously used. Temperatures also are generally lower, being from 400 deg. to 800 deg. Fah. Another important difference is lower hydrogen consumption ; it ranges from 0-700 cubic feet per barrel. The less severe operating conditions favour reactions that alter the materials causing poor fuel quality. Controlled breaking of sulphur and nitrogen bonds occurs, unstable di-olefinic compounds are saturated and oxygenated materials are reduced. Hydrocracking of the feed is minimised. Since the products from the major reactions have lower density than the parent reactants, product yields are essentially 100 per cent of the charge stock by volume. Fuel products so treated have superior stability, odour and colour, and reduced corrosive tendencies. An important result in gasoline treating is reduction in gum-forming tendency. This contributes to cleaner combustion chambers in automotive engines. These quality improvements are obtained without the treating losses, waste disposal problems and auxiliary purification steps associated with acid treating.

Research work on hydrogen treating has shown that it can be applied in a wide variety of fuel treating operations. It is not limited to fuel treating, however, and has been used as a refining step for lubricating oils and to improve the quality of virgin and cracked stocks for catalytic cracking.

*(To be continued)*

TOOTHED POWER TRANSMISSION BELTS.—A toothed power transmission belt of American design, which provides a positive non-slip drive, is to be manufactured in this country by the North British Rubber Company, Ltd., of Castle Mills, Edinburgh. This "PowerGrip" belt, as it is known, is unusually thin and has as its load-carrying element a single layer of continuously wound, high tensile strength wire cable, moulded in "Neoprene." On this tension member there are moulded equally spaced teeth and a jacket of "Neoprene" impregnated fabric which provides a wear-resistant surface for the teeth as well as protection for the tension member. This form of construction makes it possible to maintain constant tooth spacing, or pitch, and ensures accurate and positive engagement of the teeth with axially cut grooves in pulleys having the same pitch. The belts are made for speed ranges up to 16,000ft per minute, and to transmit from 1/100th to over 300 h.p. This form of belt does not stretch and its great degree of flexibility permits its use with pulley diameters as small as ¼in and operating at 10,000 r.p.m. No lubrication or dressing is required for the belt and oil has no damaging effect on it.

# Passenger Liner "Reina del Mar"

*The fleet of the Pacific Steam Navigation Company was recently increased by the liner "Reina del Mar." Of a little more than 20,000 tons gross, the ship has a length between perpendiculars of 560ft and is powered by a two-shaft arrangement of double-reduction geared turbines which develop 17,000 s.h.p. in service.*

LAST month the liner "Reina del Mar" sailed from Liverpool, under the command of Captain G. H. Rice, as flagship of the fleet of the Pacific Steam Navigation Company, which was incorporated by Royal Charter in 1840. The new liner has joined the "Reina del Pacifico" in the company's passenger service from Liverpool to Valparaiso on the west coast of South America via France, Spain, Bermuda, Bahamas, Cuba, Jamaica, Trinidad, Venezuela, Colombia, Ecuador and Peru. The older vessel, of 17,872 gross tons, was completed in 1931 and is powered by a quadruple arrangement of oil engines, while the new ship has a gross tonnage of 20,225 and is propelled by two sets of geared turbines. Twenty-five years of development in ship construction and marine engineering are embodied in the second "Queen" and the ships, both of which were built and engined by Harland and Wolff, Ltd., at Belfast, mark the progress made since the 700-ton wooden paddle ships "Chile" and "Peru" inaugurated the service in 1840.

*Main Particulars of Liner*

| | |
|---|---|
| Length overall | 600ft 7in |
| Length between perpendiculars | 560ft |
| Breadth moulded | 78ft |
| Depth moulded to "C" deck | 44ft |
| Gross tonnage | 20,225 |

*Accommodation*

| | |
|---|---|
| First-class | 207 |
| Cabin-class | 216 |
| Tourist-class | 343 |
| Officers and crew | 327 |

*Propelling Machinery*

| | |
|---|---|
| Twin-screw, double-reduction geared turbines : | |
| Service power | 17,000 s.h.p. |
| Maximum power | 18,700 s.h.p. |
| Astern power | 10,200 s.h.p. |
| Steam supply | 500 lb/in² gauge, 815 deg. Fah. |
| Two Babcock and Wilcox water-tube boilers : | |
| Steam pressure | 525 lb/in² gauge |
| Superheat | 825 deg. Fah. |
| Two Cochran auxiliary boilers : | |
| Steam pressure | 100 lb/in² gauge |

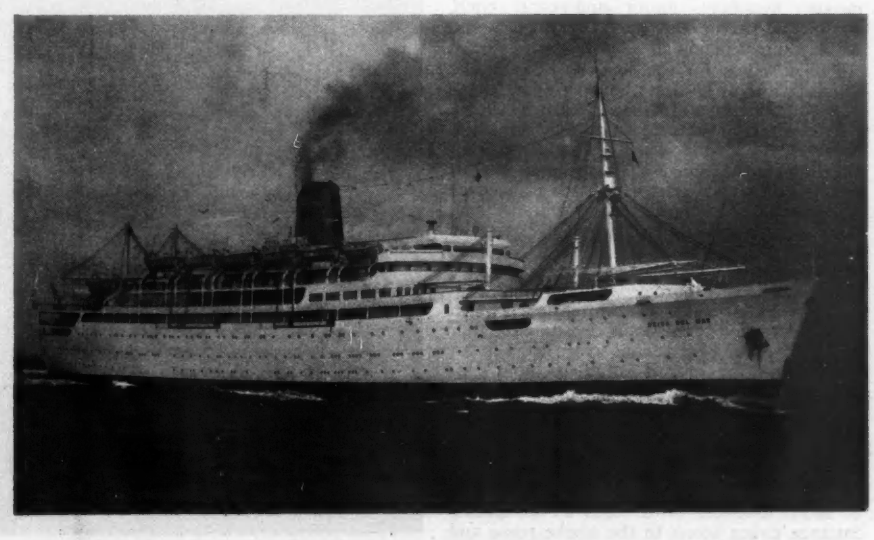
*Electrical Plant*

| | |
|---|---|
| Two turbine-driven Brotherhood generators | 1000kW |
| Three diesel-driven Harland and Wolff generators | 500kW |
| One emergency generator driven by McLaren diesel engine | 100kW |

The general appearance of the liner can be seen in the photograph reproduced below, which shows that the ship has a single mast, a large single streamlined funnel designed to avoid the nuisance of smoke and smuts on the open passenger decks, a curved and raked stem, cruiser stern and a white painted hull above the boot topping. Construction of the ship has been under the survey of Lloyd's Register of Shipping and to the regulations of the Ministry of Transport. There are four continuous steel decks, namely, "A," "B," "C" and "D" decks, a lower deck forward and aft of the combined engine and boiler-room, a short tunnel deck, and superstructures consisting of promenade, boat and navigating bridge decks. There are eleven watertight compartments and a double bottom arranged for the carriage of water ballast, feed water, fresh water, oil fuel and lubricating oil. Fresh water is also carried in wing tanks in way of the shaft tunnels and in tanks between the tunnels, and the peak tanks carry either fresh water or water ballast, while deep tanks arranged athwartship forward of the engine-room carry oil fuel. Including reserve feed water and the peak tanks the total capacity of fresh water is nearly 2400 tons, while the cross bunkers and double bottom tanks, &c., allocated for oil fuel can carry nearly 3300 tons. Three holds forward and No. 5 hold aft are arranged for general cargo and No. 4 hold aft is equipped to take insulated cargo.

## ACCOMMODATION

Accommodation for the passengers and the crew, together with space for the essential services, is arranged on "A," "B," "C," "D," promenade and boat decks. All passenger cabins and public rooms, and the deck and engineer officers' quarters are air-conditioned, while the crew accommodation has mechanical ventilation. Twenty-two special first-class cabins are equipped with individual selective temperature control, known as the "Therm-U-Reg" system. Thermotank, Ltd., has been responsible for the installation, which employs thermostatically operated by-pass valves and thirty-seven air-conditioning units where the air is filtered, cleaned, cooled or heated and the humidity controlled before being circulated. For the sake of economy a portion of the air supplied to the public rooms is recirculated, but a minimum of 15 cubic feet per minute per person of fresh air is introduced, and only fresh filtered air is supplied to the first-class lounge and cabins. It is esti-



Twin-screw steamer "Reina del Mar"

First-class lounge on promenade deck

mated that under conditions of maximum demand for cooling, the load on the refrigerating plant will total 8,000,000 B.Th.U. per hour. When air conditioning is not required the units will introduce fresh filtered air into the system. In cold weather a heating calorifier will circulate warm water to the heat exchangers at the units, so that an inside temperature of 70 deg. Fah. can be maintained with an outside ambient temperature of 30 deg. Fah. An automatically controlled humidifier valve is fitted at each unit and the plant will require a maximum of 12,000 lb of steam per hour.

Serving the crew's accommodation, galleys and pantries are ten air heating units which distribute air through punkah louvres and can maintain an inside temperature of 70 deg. Fah. with the outside temperature at 30 deg. Fah. Independent temperature control for inside and outside spaces is provided.

Cabins for the first-class passengers are on "D" deck and about 'midships on "C" deck, and are single and two-berth rooms, each having a private bath or shower. There are two suites and four de luxe rooms and fourteen specially decorated cabins. Decoration of the suites includes motifs depicting Incaic architecture and the "Boca Chica" Cartagena, while the de luxe rooms have decorative themes representative of Carribean beaches, high Andes, Morro Castle, and the Osorno volcano. The woods used include sycamore, mazur and coral birch, eucalyptus, willow and bird's eye maple, and the furniture is mainly in walnut.

Public rooms for the first-class passengers, some of which we illustrate, are on the promenade deck and right forward is the verandah, which is a glass enclosed promenade, colourfully furnished, conforming with the sweep of the bridge front and framing the lounge on three sides. Sets of double doors open on to the open promenade spaces and also give access to an entrance hall, from which glazed doors, flanked by sycamore panels decorated with murals of South American appeal, lead to the lounge. The room can be used as a cinema, a projection room being concealed at the aft end of the central dome, which has as decoration relief motifs depicting the four elements, while a cinemascope screen drops out of the ceiling at the forward end of the room. Aft of the entrance hall and to starboard is the finely panelled card room having a curved fireplace and tapestry wall decorations. To port the long gallery, which is open to the pleasantly equipped writing room and the library and decorated with marquetry panels with composite designs of South American birds, leads aft to another entrance giving access to the smoke room and the cocktail bar. The latter is panelled in oak, while the "H"-shaped smoke room has banquette seating in the bay windows and carved and painted figures of Inca and Chimu chieftains housed in niches in the panelling opposite the bar. Aft on the deck over is the open air swimming pool, having glazed folding Essavian screens to act as a wind shield, and the Lido café, where the bar front carries a mosaic showing tropical fish in a natural setting. On the same deck to port is a self-contained space entirely reserved for children. There is a play room and a dining room to seat twenty-four, and an open deck space, containing a paddling pool enclosed by railings to ensure absolute safety.

The spacious main entrance, decorated with its full-size illuminated allegorical figure, is on "D" deck and there is an arcade and shopping centre and other amenities on the port side of "C" deck amidships. The main staircase leads down from the promenade deck to the restaurant on "B" deck and there is also a lift for the passengers' convenience. The restaurant can accommodate 218 persons at tables for two, four, six and eight, and extends for the full width of the ship. French figured birch, Australian walnut, burry ash and sycamore have been used for the panelling and also for the furniture. A mural of composite subjects representative of scenes encountered on the route followed by the ship is at the forward end of the room facing the musicians' gallery, which is decorated with musical motifs carved from "Perspex." Four marine subjects are carved from the same material, and these are suspended between pillars in the centre of the room.

Cabins for the cabin-class passengers are aft on "B" and "C" decks and are single, double and four-berth rooms, the furnishings being of walnut with a number of other woods being used in the scheme of decoration. The lounge, in a house on the promenade deck, is an airy room with windows in all four sides, those in the forward bulkhead overlooking the open air swimming pool. Light-coloured woods, such as willow and ash, have been used for the panelling and the lounge, which houses the library and is also equipped to serve as a cinema. The furniture is arranged in groups looking toward the central dancing space. A "T" stairway at the aft end leads down to the smoke room immediately below on "D" deck, where the main decoration is a panel, which shuts off the bar, in wood marquetry displaying the customs and characteristics of countries bordering the Pacific coast of South America. There is a children's play room on the same deck and a combined shop and hairdressing saloon on "C" deck. The restaurant, illustrated herewith, accommodates 216 persons at tables for two, four and six, occupies the full width of the ship, and the space is divided by low screens and the extensive use of banquette seating. For the panelling aspen and African white mahogany have been used together with figured cinnamon wood. A piece of sculpture in "Perspex" and entitled "Merchild" surmounts the bow-fronted sideboard and, together with mirror panels, forms the main decoration of the room.

One, two, three and four-berth cabins forward on "A" and "B" decks, and panelled in "Formica," accommodate the 343 tourist passengers, for whom there is a lounge to port and a smoke room to starboard on "B" deck. Both rooms are furnished with banquette seating and tub chairs and the walls are lined with "Warerite," which incorporates colourful murals depicting South American scenes. There is a large tourist restaurant on "A" deck, which has tables for four and six and can accommodate 174 persons at one sitting.

The captain has his apartments on the navigating bridge and the deck and engineer officers have their cabins in a house on the boat deck, the chief engineer being provided with a suite of

Card room looking inboard

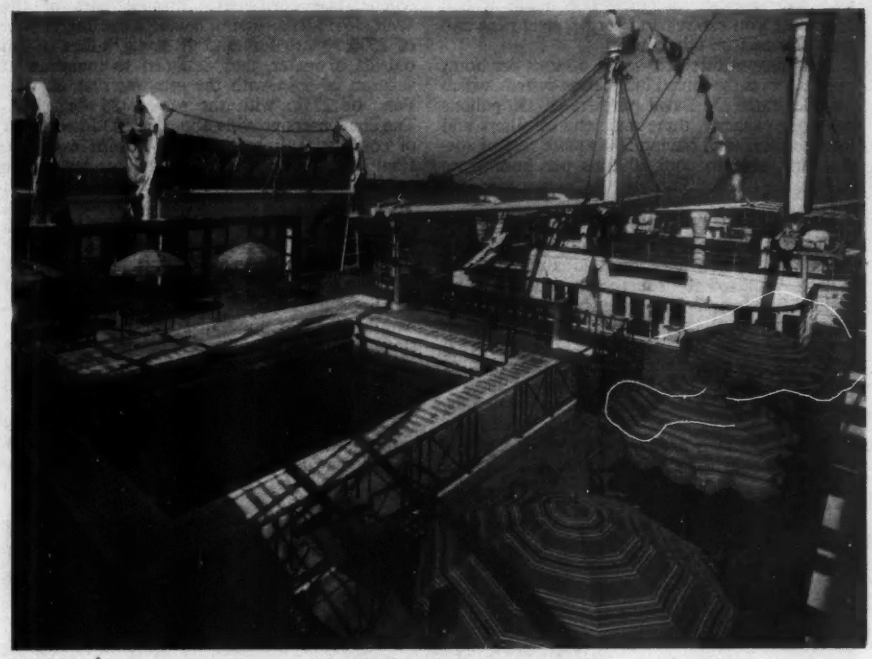
rooms. There is an officers' smoke room and a separate mess for the engineers, there being a lift connecting the engine-room and their accommodation. Cabins for the crew are mainly on "A," "B" and "C" decks, the seamen and petty officers being aft on "C" deck, the stewards forward on "C" deck and aft and amidships on "A" deck, while the engine-room staff are accommodated to starboard on "B" deck. There are separate messes for different categories of the crew and space for recreation.

The interior decoration of the ship has been the responsibility of the following firms :— Waring and Gillow, Ltd., Heaton Tabb and Co., Ltd., Hampton and Sons, Ltd., White Allom, Ltd., and Maple and Co., Ltd.

### Ship Auxiliaries and Service Equipment

The equipping of the galley on "B" deck for the first-class and cabin-class passengers has been mainly the responsibility of H. Wilson and Co., Ltd., and there are separate galleys for the tourist passengers and for the crew. The health of those on board is adequately guarded by the medical services provided, which include hospitals for each class of passenger, a separate hospital for the crew and an isolation hospital right aft on the promenade deck. There is also a large laundry, fitted out by Thomas Bradford and Co., Ltd., complete with washers, hydro-extractors, drying tumblers and a calender, at the aft end of "B" deck.

For the convenience of the first-class passengers there is a lift, rated to raise a load of 1500 lb at 150ft per minute, which links the restaurant on "B" deck with the promenade and intermediate decks. The engineers' lift has been noted already and in addition there is a service lift, which serves the pantries on the various decks. Ventilation arrangements for the passenger accommodation has been referred to earlier, but Thermotank, Ltd., has also supplied a number of centrifugal fans to supply atmospheric air to kitchens, refrigerating machinery space, mail and parcel room, baggage store, stabiliser compartment, and other spaces. There is also a battery of fans forming the mechanical exhaust operating in conjunction with the air conditioning system. General cargo spaces Nos. 1, 4 and 5 are ventilated by torpedo exhaust fans, but provision is made for reversing rotation. For air conditioning there are thirty-seven units placed on various decks and the machinery consists of two eight-cylinder "Veebloc" compressors, each powered by a 238 h.p. motor, four sea water and four fresh water circulating pumps of 45,000 and 33,000 gallons per hour capacity respectively. For refrigeration purposes for the cargo and provision rooms there are three twin-cylinder "Arcton" compressors, two 5500 gallons per hour sea water pumps and three 6000 gallons per hour brine pumps, and the plant maintains a supply of ice water at thirty points located in the passenger and crew accommodation.



First-class swimming pool and lido

The position of the cargo holds has already been mentioned; they are served by a complement of thirteen 5-ton and four 10-ton derricks operated by six 3-ton and four 7-ton Laurence Scott electric winches. For handling the anchors there is a Stothert and Pitt windlass having cable lifters capable of exerting a pull of 31 tons at 24ft per minute and warping ends able to pull 10 tons at 85ft per minute. There are also two capstans of the same make on "D" deck aft, rated to pull 10 tons at 67ft per minute. John Hastie and Co., Ltd., has manufactured the two-motor, four-ram electro-hydraulic steering gear, each power unit of which can move the rudder from hard over to hard over in thirty seconds with the ship moving at full speed ahead. A separate compartment, forward of the machinery space, houses the Denny-Brown stabilising equipment and Adams Hydraulics, Ltd., has supplied two automatically operated sewage plants, one forward and one aft, each unit consisting of two vertical pumps, which are each capable of handling 200 gallons of sewage per minute, and one collecting tank.

Five electrically operated watertight doors are located in the tunnel and machinery spaces, and a further twelve on "A" deck, while on "B" deck are fourteen hand-operated doors. In addition, there are four shell doors, two to oil filling stations and two to the storing passage, and a number of fire-resisting doors. The latter form part of the fire protection arrangements, which include a Grinnell sprinkler system throughout the accommodation, a Kidde-Rich fire extinguishing and detection system for the cargo spaces, and a total flooding $CO_2$ system for the engine and boiler-room. The sprinkler equipment is divided into twenty-one sections, each with its own controlling valves.

For the ship's communication systems The General Electric Company, Ltd., has supplied a twenty-five-line automatic telephone exchange for the use of the ship's officers and a 150-line automatic board for the convenience of the first-class passengers. A total of fourteen lifeboats is carried under Stone's "Marepa" davits and include one Class "A" and one Class "B" motorboats, two accident boats and ten lifeboats fitted with Fleming hand propelling gear. All the boats are of aluminium alloy and were built by William Weatherhead and Sons (1954), Ltd.

First-class restaurant

### Propelling Machinery

For propelling the ship the builders constructed two sets of Parsons triple-expansion turbines, which are designed to develop a total ahead power of 17,000 s.h.p. when driving the propellers at 112 r.p.m. through double-reduction, double-helical interleaved gearing. The propellers have a diameter and pitch of 18ft 6in and 18ft 9in respectively, and a developed surface of 110 square feet. Each turbine drives its own primary pinion through a flexible coupling, which gears into a separate primary wheel, and the secondary pinions are geared to the main wheel. For astern working 10,200 s.h.p. is available and the three-row h.p. astern turbine is incorporated at the steam end of the i.p. ahead turbine, from which it is separated by a diaphragm. The h.p. astern turbine exhausts to the three-row l.p. astern turbine, which is located in the exhaust casing of the l.p. ahead turbine. The h.p., i.p. and l.p. turbines, which work in series, are of all reaction design, while the astern turbines have impulse blading, all blading being of stainless iron. All the rotors are of forged steel, while cast steel has been used for the casings except the l.p. casing, which is of cast iron.

The primary gears are of all addendum design and the secondary gears are of deep form

standard involute design. The main wheels have cast iron centres and forged steel rims and the gear cases are fabricated.

A battery of three Drysdale, 60 tons per hour, pumps serves the forced lubrication system, which includes three De Laval purifiers of 350 gallons per hour capacity, three magnetic oil filters and four coolers, each having 500 square feet of surface and able to cool 60 tons per hour from 125 deg. to 105 deg. Fah.

### Steam Generating Plant

The steam supply for the main and auxiliary machinery is provided by two Babcock and Wilcox controlled superheat, double-cased, divided furnace, oil-fired water-tube boilers, with separately fired superheaters and fitted with economisers and air heaters. Steam is generated at 525 lb per square inch and 825 deg. Fah. at the superheater outlet and the boilers have a total generating surface, including water walls, of 18,750 square feet. The surface area of the superheaters is 3460 square feet, that of the economisers is 6240 square feet, and the air heaters have 13,100 square feet of heating surface. The generating tubes and those for the division wall are of 2in outside diameter by 9 s.w.g., while the superheater tubes are of 1¼in outside diameter by 12 s.w.g. The "U" bend superheater is designed for five steam passes and both the horizontal tubular air heater and the economiser are of Babcock and Wilcox pattern. At normal service power the boilers supply 170,000 lb of superheated steam per hour, or 187,000 lb on overload.

Two Wallsend-Howden oil-burning equipments, rated at 12,000 lb per hour, are installed and each boiler has four burners in the saturated and four in the superheater furnaces. Clyde manually-operated soot blowers are fitted, those for the furnaces having retractable nozzles, while those for the economisers and air heaters are of the non-retractable design.

The oil is burned under Howden's system of forced draught, each boiler having a double inlet forced draught fan rated to deliver 34,500 cubic feet per minute of air at 80 deg. Fah., against a pressure of 9·75in water gauge. The induced fan of single inlet pattern can deal with 54,500 cubic feet per minute of gas at 340 deg. Fah., against a pressure drop of 8·75in water gauge.

When the ship is in port the demand for steam for the various ship's services is met by two Cochran auxiliary oil-fired boilers, each able to produce nearly 6000 lb of saturated steam per hour at 100 lb per square inch. In addition, there is a Weir steam-to-steam generator which produces 12,000 lb of saturated steam per hour at 100 lb per square inch gauge.

Under each set of turbines there is a two-flow regenerative condenser, forming part of the Weir closed feed system, having a cooling surface of 8500 square feet and 18 s.w.g. tubes of ¾in outside diameter, and designed to maintain at vacuum of 29in with the sea water at 60 deg. Fah., or 27½in with the sea at 85 deg. Fah. The condensers provide about 52,500 lb per hour of condensate from the main turbine exhausts. Four Drysdale pumps of 5500 gallons per minute capacity circulate the sea water. G. and J. Weir Ltd. also supplied three extraction pumps, two working and one standby, each of 85,000 lb per hour capacity, two three-stage steam air ejectors, drain coolers and feed heaters, which raise the temperature of 170,000 lb of feed water per hour to 300 deg. Fah. The feed water is handled by two horizontal turbine-driven, two-stage centrifugal pumps able to deliver against a pressure of 675 lb per square inch, and there is a 6in by 8½in by 18in assistant feed pump rated to deliver 22,000 lb of feed water per hour.

For the auxiliary boilers there are two direct-acting feed pumps each able to supply 20,000 lb per hour against a pressure of 100 lb per square inch and an auxiliary condenser, having a surface of 600 square feet, to deal with 20,000 lb of exhaust steam per hour. A Weir evaporating and distilling plant is installed, consisting of a 70 tons per day evaporator, using saturated steam at 100 lb per square inch, and one 70 tons per day distiller. The 70 tons of fresh water is required for boiler feed make-up and for domestic purposes. For the latter, single distillation is used, while the former is double distilled. There are two evaporator feed pumps and one 15,000 gallons per hour combined distiller salt water circulating and fresh water pump.

With certain exceptions most of the engine and boiler-room auxiliaries are electrically driven and have been manufactured mainly by Drysdale and Co., Ltd. In addition to the main circulating pumps and the lubricating oil pumps, there are two sanitary pumps, one of 150 tons per hour capacity against a head of 55ft, and another of 100 tons per hour against a head of 140ft; an auxiliary salt water circulating pump rated at 100 tons per hour against a head of 25ft; two bilge and ballast pumps rated to deliver 150 tons per hour against a 55ft head, and a fire and bilge pump of similar capacity. Domestic fresh water is handled by two 30 tons per hour pumps, and for the hot salt water there is a pump of 15 tons per hour capacity against a 140ft head, while for oil fuel transfer there is a two-throw pump rated to handle 60 tons per hour against a 70ft head and a diesel oil transfer pump of 25 tons per hour capacity.

All the electrical generating plant is installed at the aft end of the engine-room and consists of two 1000kW Brotherhood turbo-generators in addition to three Harland and Wolff 500kW diesel-driven generators.

The 1000kW generators are driven by a single-cylinder, multi-stage, axial-flow impulse turbine, which takes superheated steam and runs at 6000 r.p.m., driving the generator at 750 r.p.m. through gearing. Each turbine has its own condenser and a Worthington-Simpson circulating pump, and there is a Weir three-stage air ejector with intermediate surface condenser and after heater, single pass glands condenser, and extraction pump. The main lubricating oil pump is driven from the turbine shaft while the auxiliary pump is turbine driven. One generator is on the centre line and the other just outboard of the starboard shafting.

Two of the diesel-driven generators are outboard of the port shafting and the third outboard of the starboard shafting. Each of these 500kW generators is powered by a Harland and Wolff four-stroke, single-acting, fresh water-cooled, turbo-charged, diesel engine having eight cylinders of 316mm diameter by 420mm stroke. Associated with the generators is a fresh water cooler and circulating pump, a salt water circulating pump, and a motor-driven air compressor. For emergency purposes there is a 100kW generator, driven by an eight-cylinder McLaren diesel engine, mounted in a house at the aft end of the promenade deck. In the same space there is a room for the emergency 220V battery which will automatically maintain essential services for a limited period of time should the supply from the main generators fail.

**Cabin class restaurant**

## Calder Works Nuclear Power Plant

The British Nuclear Energy Conference is to hold a symposium on "Calder Works Nuclear Power Plant" on November 22nd and 23rd next, at the Institution of Civil Engineers, 1–7, Great George Street, London, S.W.1. The first session at 10 a.m. on November 22nd will be concerned with the general design of the plant and will consist of a group of three papers by Sir Christopher Hinton, R. V. Moore and B. L. Goodlet. The afternoon session will deal with technical research problems. Six papers will be discussed: on experimental heat transfer work, by P. Fortescue and W. B. Hall; experimental physics, by P. Mummery; shielding design, by W. Bonsall and C. Horton; basic design of reactor, by G. Packman and B. Cutts; early metallurgical problems, by L. M. Wyatt and R. A. V. Huddle; metallurgical developments for Calder Works, by L. Grainger and A. B. McIntosh.

Engineering design will be the subject of the morning session on November 23rd. The five papers for discussion will be: design and construction of the reactor vessel, by G. Browne, M. Noone and R. F. Bishop; uranium fuel handling, by K. Dent and G. W. Grossmith; the design of important plant items, by A. T. Bowden and G. H. Martin; steam cycle analysis, by W. R. Wootton, and the design and construction of heat exchangers, by H. Morris and W. R. Wootton.

The light engineering and electrical side of the Calder works nuclear power plant will be discussed in the afternoon session on November 23rd. Four papers will provide a basis for the discussion: equipment for control of the reactor, by J. H. Bowen and S. A. Ghelib; the detection of faulty fuel elements, by E. Long, J. M. Laithwaite and K. W. Cunningham; reactor control and instrumentation, by R. J. Cox and K. R. Sandiford, and system control and protection, by J. H. Bowen and E. Anderson.

In the final session, on November 23rd, R. V. Moore will discuss future developments of gas-cooled reactors, and Sir Christopher Hinton will give a summary of the proceedings.

Publication on Lead.—The first issue of a new periodical *Lead News* has just been published by the Lead Development Association, Eagle House, Jermyn Street, London, S.W.1. The object of this new periodical is to supply authoritative information to industrial and commercial users on the many ways in which lead can be employed in modern production techniques. The first issue contains articles on the use of lead in atomic energy, new batteries for specialised application, better fluxes for soldering and on lead components which check tarnish.

# International Machine Tool Exhibition—No. I

THE International Machine Tool Exhibition begins to-day at Olympia, London, and will be open daily from 9.30 a.m. to 6 p.m. until Friday, July 6th. This exhibition which is organised by the Machine Tool Trades Association of Great Britain and held every four years, provides engineers in this country and buyers from abroad with an excellent opportunity to see the latest British developments in machine tools, woodworking machines, ancillary equipment and tools. In addition there is on view an interesting selection of machines and equipment from other countries, including Belgium, France, Germany, Holland, Italy, Scandinavian countries, Switzerland and the United States. As at previous exhibitions, many of the machines are shown in operation and technical staff is on hand to discuss individual machining problems with potential users. The number of exhibits is indicated by the fact that they cover an area of some 252,000 square feet and more than 200 firms are showing examples of their own products and the equipment of overseas firms they represent.

The exhibition is truly international in character and it is of particular interest owing to the developments which have taken place in transfer machines, automatic control equipment and special purpose machines since the last exhibition four years ago. It comes at a time when many medium-sized firms in this country are becoming increasingly interested in the automatic control of machine tools, and as yet have had but little opportunity of seeing how far the new techniques can be adopted for their own establishments, or what suitable equipment is available. For some time there has been criticism in this country of machine tool manufacturers for their tardiness in introducing in fuller measure such things as automatic cycle operation, pre-setting equipment and push-button control on many of their machines and in the development of special purpose transfer machines. Preliminary information on which our descriptions are based indicate that quite a number of the British exhibits will provide an effective answer to these criticisms. For, although perhaps many new British machines still retain their sturdy workmanlike appearance, they can compete on the grounds of speed, accuracy, simple operation and, where required, automatic control, with most contemporary foreign machines.

It will be appreciated that with the amount of space we can fairly devote to the exhibition it will not be possible to deal with anything like all the machines shown. In any case, we have already described quite a number of machines of recent design which have been introduced by British makers, as well as many of those machines of foreign design which have been exhibited at the various European machine tool exhibitions and at Chicago last year. For this reason we propose to deal in some detail mainly with a representative selection of machines of improved or new design in order to give a general impression of the size and scope of the exhibition and the trend of development, particularly in this country.

### Churchill Machine Tool Company, Ltd.

An automatic sizing internal grinding machine is one of the machines of entirely new design made by the Churchill Machine Tool Company, Ltd., Broadheath, near Manchester. This machine (Fig. 1) swings 12in inside its water guard and 19in over the table, and the table has a maximum traverse of 18in. It can be operated on a double automatic cycle with intermediate truing or on a single automatic cycle. The choice of cycle is determined by the work to be ground, and the essential difference is in wheel truing, which in the single cycle occurs just prior to the grinding wheel entering the bore of the work, whereas in the double cycle the wheel truing takes place between roughing and finishing stages. The feed is applied by cross adjustment of the grinding wheel spindle slide; work oscillating mechanism can be incorporated, if required, and this equipment is fitted to the machine exhibited at Olympia.

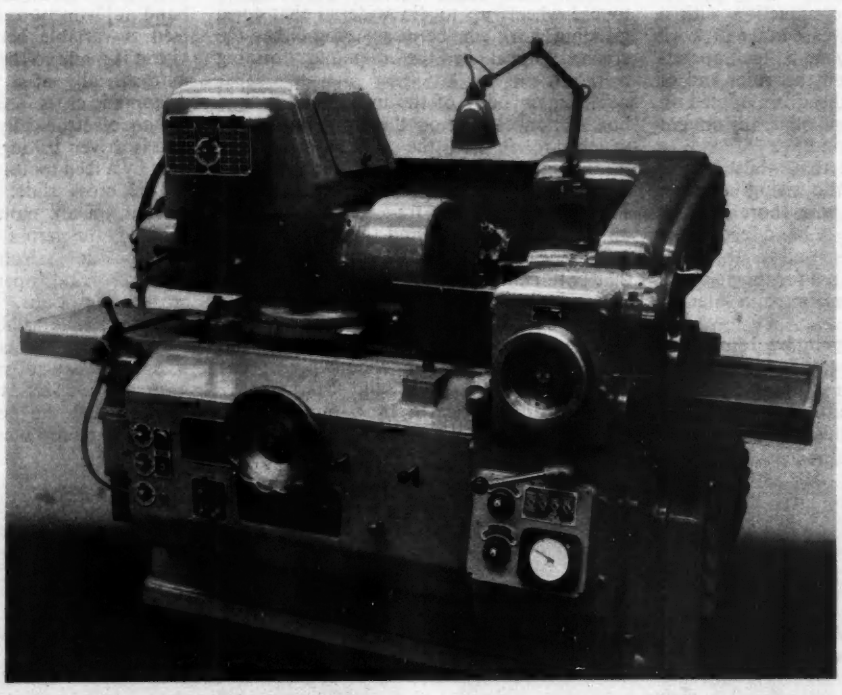


Fig. 1—Automatic sizing internal grinding machine which can be operated on a double automatic cycle with intermediate truing or on a single automatic cycle—Churchill

The cross slide carrying the grinding wheel spindle is mounted on rollers to ensure sensitive feed movement. Continuous cross feed to the grinding wheel is operated by a cam mechanism, which gives a constantly diminishing rate of feed starting at the maximum when the wheel enters the bore of the work, and gradually decreasing to zero as the bore reaches size. A grinding cycle is completed for every revolution of the cam. The camshaft is driven by a variable-speed motor, which in conjunction with "pick-off" gears in the drive gives a wide range of feed cycle times. Roughing and finishing feeds can be selected independently and after being preset the change from roughing to finishing becomes automatic. An electrically controlled dwell at sizing position gives a high finish and the dwell period is preset by reference to a dial on the front of the feed control panel. The machine is also fitted with a "feed accelerator," by means of which the rate of feed is automatically increased to provide the wheel with a quick approach until it commences to cut. The cycle time is therefore reduced should the grinding tolerance be less than that for which the feed is set.

The single automatic cycle commences when the starting lever is operated, the work table moving in at fast speed towards the grinding wheel. When the truing device, which is mounted on the work table immediately in front of the work, reaches the grinding wheel the work table slows down to truing speed, the diamond moves down automatically into position and the wheel is dressed. The table then speeds up until the grinding wheel enters the bore of the work. At this stage the work table commences to reciprocate at grinding speed, the cross feed movement operates and both continue until the finished size is reached. The grinding wheel then drops back from the work and the work table runs out at fast speed to the rest position for unloading. This method of operation is generally suitable for most work where there is a stock removal of 0·008in to 0·012in, providing this is reasonably consistent in all the workpieces to be ground. The single cycle is also recommended where the "finish" requirements are not too exacting, and under these particular conditions the fastest production times are

usually obtained by the single cycle method of operation.

In the double automatic cycle, operation of the starting lever causes the work table to move in at a fast speed until the grinding wheel enters the bore. The traverse then slows down to grinding speed and the work table reciprocates on a stroke sufficient to cover the full length of the bore. At this stage the cross feed of the wheel commences and both movements continue until roughing size, which may be only 0·002in-0·003in from finished size, is reached. The grinding wheel then drops back from the work and the work table retracts until the rear edge of the wheel is just clear of the diamond position. The work table then slows down to truing speed and the diamond moves into truing position to dress the wheel. Immediately the diamond passes the rear edge of the wheel on the return dressing pass the diamond retracts, the work table reverses and the traverse speed is increased until the grinding wheel again enters the bore. Reciprocation of the work and the cross feed of the wheel then recommence. When finished size in the bore is reached the automatic dwell comes into operation, at the completion of which the work table runs out at a fast speed to stop position for work unloading. In plunge grinding the automatic cycle operates similarly, except that the work table remains stationary when the wheel enters the bore, or it can be oscillated slightly as required by the nature of the work.

The work spindle runs in a ball and roller bearing workhead and is driven by a two-speed motor which, in conjunction with a four-speed cone pulley gives a range of work speeds from 48 to 354 r.p.m. Chuck operating mechanism is fitted on the outer end of the spindle, and the workhead is mounted on a swivel base giving an angular adjustment up to 30 deg. for taper grinding.

The maker points out that whilst this is basically a fully automatic sizing machine it can deal economically with short runs, or even single components. A hand feed wheel with micrometer adjustment and suitable dead stops can be brought into use for the machine to be used as a non-automatic plain internal grinder.

On the firm's "AW" 6in by 18in automatic grinding machine to be seen on the stand, the wheelhead slide is set at a definite position in which it remains throughout the grinding operation. On this "Fulcro-sizer" machine feed is applied by tilting the table carrying the work towards the grinding wheel, the table being mounted at its inner side on knife edges. The front of the table is lifted by a link motion operated by a tension rod moved by an electro-hydraulic control unit at the right-hand end of the table.

The operator simply places the work in a supporting cradle and when he starts the automatic cycle by moving a single lever, the tailstock centre moves in hydraulically to pick up the work between the centres. The table then tilts the work quickly towards the grinding wheel and at a preset point the slow feed for the actual grinding operation begins. The design of the link motion ensures that the rate of feed is gradually reduced until it reaches the sizing position. The table then remains in a dwell position for a predetermined period which is shown to the operator by an indicator light on the wheelhead. At the end of the dwell the table falls back to its original position, the work stops rotating, the tailstock centre withdraws and the finished workpiece falls back into the supporting cradle to complete the automatic cycle.

The hydraulic table traverse of this machine gives a stepless speed range of up to 192in per minute. The dead centre workhead is driven by a variable-speed motor and two-speed cone pulleys giving two speed ranges of 20 to 120 r.p.m. and 50 to 300 r.p.m.

Another new machine on this stand is the "OSB" 42in by 10in surface grinder shown in Fig. 2, which is designed for very highly finished work to close limits. It is designed to use wheels up to 4in wide so that form grinding work can be done using either the crushed wheel or the diamond forming methods.

The main body of the machine is a rigid box section casting on the front portion of which are formed the slideways for the traversing table, while the rear portion carries the slides for the wheelhead column. The hydraulic table traverse gives speeds up to 90ft per minute and the hand traverse is interlocked with the hydraulic control so that both cannot be engaged simultaneously. The grinding wheel spindle has a built-in 5 h.p. motor drive, the rotor being assembled directly on the wheel spindle, which carries a standard 12in by 2in wide wheel. The adjustable solid-cone spindle bearings are automatically lubricated by a motor pump unit interlocked with the drive, so that spindle rotation cannot start until the lubricant pump is working.

Cross movement of the wheelhead carriage is operated by an auxiliary hydraulic mechanism and can be adjusted to give from 0·010in to 0·150in of movement at each traverse stroke. Maximum cross movement is 10in and provision is made so that the cross feed can be cut out automatically at a predetermined position. The cross traverse can also be operated independently by hand with separate coarse and fine movement controls. The vertical feed of the grinding wheel is accurately adjusted by means of a precision ground screw, coarse and fine hand movements being provided. The maximum height admitted between the table and the full-size grinding wheel is 16in. As can be seen from the illustration, the controls for the vertical wheel feed are carried directly on the wheelhead in a position convenient for the operator. All other mechanical, hydraulic and electrical controls are grouped in the apron on the front of the machine.

Another new grinder is the 48in by 12in open-side, heavy-duty surface machine, shown in Fig. 3. A wheel head of unit construction is rigidly secured to its slide casting and the grinding wheel spindle is driven through vee belts by a 7½ h.p. motor. The cross slide carrying the wheel head has vertical adjustment on the column to provide wheel feed and the cross slide movement is effectively counterbalanced to give easy and sensitive feed movements.

Vertical feed can be applied automatically at each end of the cross traverse stroke or by hand adjustment as desired. The automatic feed is variable between 0·002in and provision is made so that the feed can be cut out automatically at a predetermined position. Automatic cross feed to the grinding wheel is by an electronically controlled mechanism and is driven through a screw and reduction gear by a feed motor mounted at the rear end of the cross slide. The controls for this mechanism are mounted on a panel at the end of the cross arm and comprise a three-position selector switch giving power traverse, hand operation and intermittent cross feed motions. The stepless intermittent cross feed is adjustable from $^{1}/_{25}$in up to 1¼in per stroke by means of a control knob. By means of a control switch the length of intermittent cross feed is reduced to a minimum as it reaches the point of reversal, thereby ensuring close accuracy of reversal and

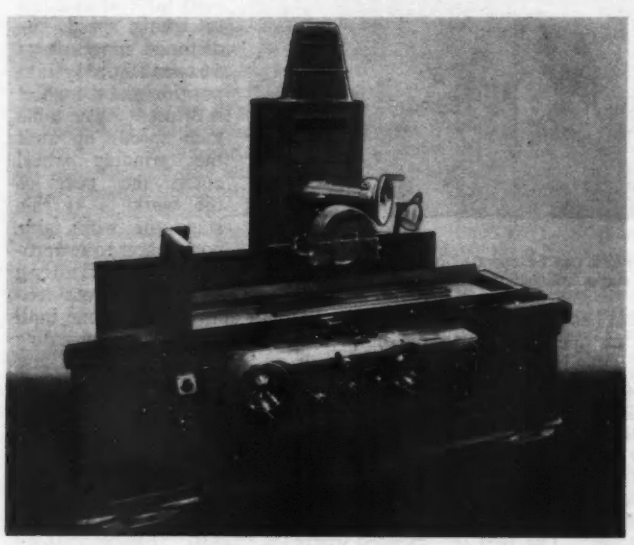


Fig. 2—Surface grinding machine of 42in by 10in capacity with hydraulic controls—Churchill

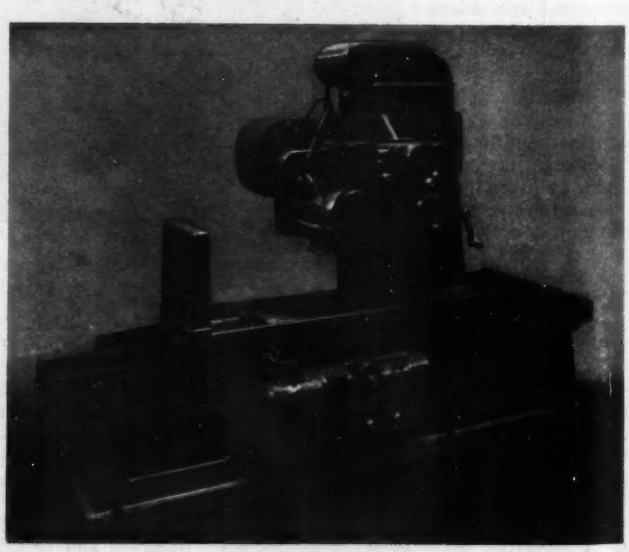


Fig. 3—Open-side heavy-duty, 48in by 12in, surface grinding machine —Churchill

eliminating the risk of overrunning the position when grinding recessed faces. A second switch is provided to give a cross feed at one end only of the table stroke. A separate motor and reduction gear provide a slow cross traverse for wheel truing purposes. The drive for the wheel truing motor is engaged by a selector switch on the front apron of the machine and a clutch giving a continuous slow traverse speed suitable for wheel truing.

The table traverse is hydraulically variable up to 100ft per minute and hand traverse is also fitted. All controls for the table traverse motion are centrally positioned, together with the push button motor controls in the apron on the front of the machine. The controls for the grinding wheel vertical and cross movements are carried on the front end of the cross slide in a convenient position.

### William Asquith, Ltd.

The firm of William Asquith, Ltd., Halifax, has long specialised in the design and manufacture of drilling machines, and some interesting examples of its latest types of radial and other machines are exhibited. A new machine of interest is the "O.D.4" vertical drilling machine equipped with a precision compound table, as shown in Fig. 4. This machine has a capacity of 3½in in mild steel and 4in in cast iron, and its table is 4ft 9in by 2ft 11in overall.

The top slide of the table, which carries the work, is traversed longitudinally by a screw, and the middle slide on which it is mounted has transverse movement on the bed ways.

Longitudinal quick-power traverse of the table is derived from a 3 h.p. motor mounted directly beneath the middle slide, and driving through vee ropes and worm gearing. Quick-power motion is available in both directions and is controlled by push buttons. Hand motion to the longitudinal adjustment is by a handwheel at the front of the middle slide, transmitting through bevel and worm gearing. Power for quick transverse traverse is supplied by a 3 h.p. motor mounted directly beneath the middle slide on the opposite side to the longitudinal traverse motor. Transmission of this drive is similar to the longitudinal traverse motion, a hand-wheel for transverse traverse being mounted on a box attached to the front of the table base.

The table is set in position with measuring rod equipment and micrometers. This equipment is carried in hardened steel channels and protected by transparent guards. Positioning is effected using dial indicator boxes which provide visual data for the measuring rods. Automatic trips, operating through the medium of the measuring rods, enables the table to be quickly traversed to a point very close to the final index position, and final adjustment is quickly made by means of fine hand motion in conjunction with the dial indicators. Rules and pointers on the measuring rod channels provide a useful guide to the rough setting and the selection of the appropriate measuring rods.

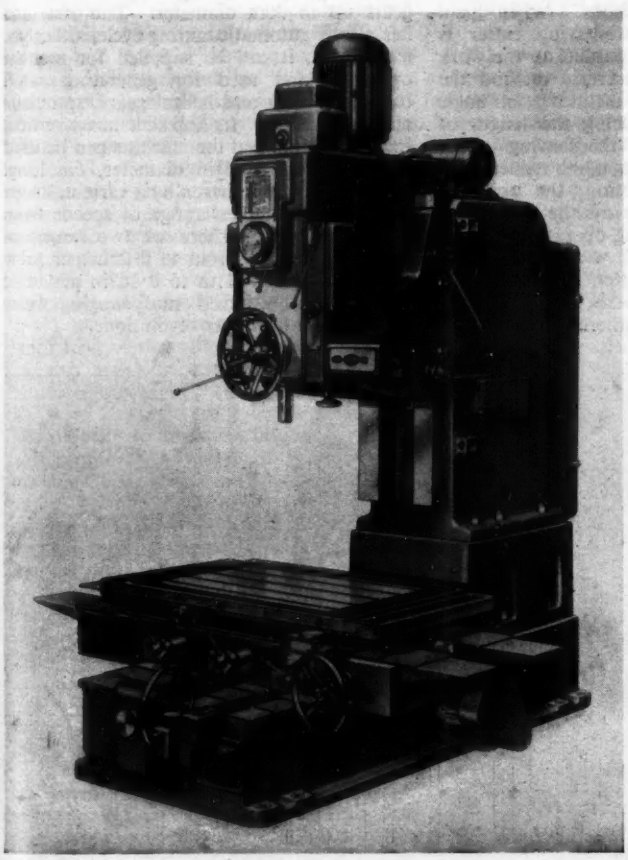


Fig. 4—Vertical precision drilling machine with precision compound table —Asquith

It is stated that the measuring rods and micrometers are guaranteed to be accurate within 0·00005in, and table movements of 0·0001in can be readily appreciated by means of the dial indicator. Alternative table setting methods available for the machine include the use of an optical micrometer reader, which permits direct rule reading for table positioning, and electronic control giving fully automatic positioning to predetermined settings.

The drilling head is mounted on an adjustable head which has 18in of vertical movement on the column of the machine, power elevation being through a screw driven by vee ropes, worm gearing and a motor. The spindle is driven by a reversing 15 h.p. motor mounted on its slide and it has eighteen speeds in three alternative ranges—1550 to 9 r.p.m., or 1100 to 14 r.p.m., or 775 to 9½ r.p.m.—the nine feed rates being from 0·002in to 0·040in per revolution. Speed selection is by use of a direct-reading index plate and two levers; when required, threading change wheels can be provided to give the required lead for any recognised thread between 6 and 40 T.P.I. As can be seen, all levers and handwheels for the control of the spindle movements are conveniently grouped on the head, and the table controls, measuring equipment, &c., are grouped at the front of the table.

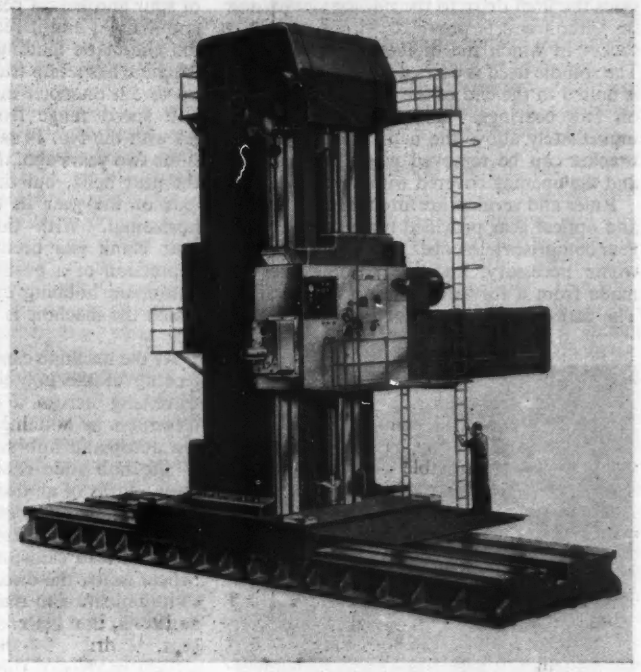


Fig. 5—10in spindle, ram-type, horizontal milling and boring machine —Asquith

A new floor-type 10in horizontal milling and boring machine of this firm to be seen in Fig. 5 is of very rigid construction to enable heavy milling operations to be performed. The heavy box-section slide on which the main 100 h.p. driving motor is mounted carries a ram of rectangular section, which houses the milling sleeve and spindle. This slide has a vertical traverse of 15ft on the column of the machine, the travel of the ram being 5ft, and of the spindle in the ram 6ft 6in. The front of the ram is provided with a facing to which can be bolted various kinds of milling attachments, and these attachments, when fitted, are driven by the milling sleeve or the spindle. The flange at the front end of the milling sleeve is arranged to carry milling cutters, and, if so desired, a surfacing slide attachment can also be fitted to the flange. When this surfacing slide is applied provision is made to obtain feed changes and full control of the slide, thus giving the facilities of a built-in facing slide.

The spindle is driven from the milling sleeve and the range of speeds available is steplessly variable from 1 to 275 r.p.m., there being twelve feed rates for both the ram and the spindle from 0·0083in to 0·10in per revolution. The range of slide and column feeds is available in three alternative groups, each being steplessly variable.

A high-speed spindle can be mounted on the front end of the ram. In this case the drive is taken from the pinion shaft, which

gives the final drive to the milling sleeve, and the pinion end is provided with a broached socket in which the high-speed spindle fits. The spindle itself is carried in a bracket which is bolted to the end of the ram, and mounted on ball bearings. This spindle is situated immediately above the main spindle and its bracket can be removed when not required and the opening covered with a plate.

Rules and verniers are fitted for all traverses and optical gear provided for readings. This gear comprises telescopes, prisms and mirrors, where necessary, and the readings are all made from a forward position on the slide. The main control panel for the operation of

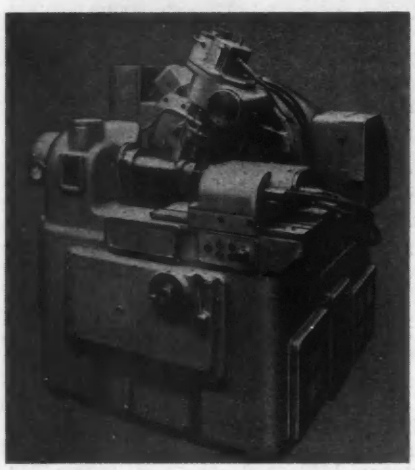


**Fig. 6—"Hydrax" No. 7 production gear hobber for cutting gears with a maximum diameter of 7½in and face width of 4¾in—Brown**

the machine is on the slide and carries the push-buttons and dials for all the motions, including those for speed and feed variation and steering control, used when milling irregular surfaces. A pendant carries button controls for the main motor, traverse motors for the ram and spindle, and for the control of the feed to the ram and spindle, for which an electrically-operated clutch is incorporated in the feed system.

### David Brown Industries, Ltd.

A recent development of the "Hydrax" high-speed gear hobber of David Brown Industries, Ltd., Sherbourne Street, Manchester, is the No. 7 machine shown in Fig. 6. It is designed for the automatic production of spur and helical gears up to 7½in diameter and 4 D.P., and if required can be arranged for automatic loading of components. The machine has a hob traverse of 5in, takes hobs up to 5in diameter and 5in wide, and has a hob speed range from 100 to 600 r.p.m. As with the No. 14 machine, first introduced some two years ago, the hob traverse is along the gear helix, but on the new machine the axis of the gear in the cutting position is horizontal. With this machine, once the gear blank has been loaded and clamped, depression of a push-button starts the fully automatic hobbing cycle, on completion of which the machine is automatically switched off.

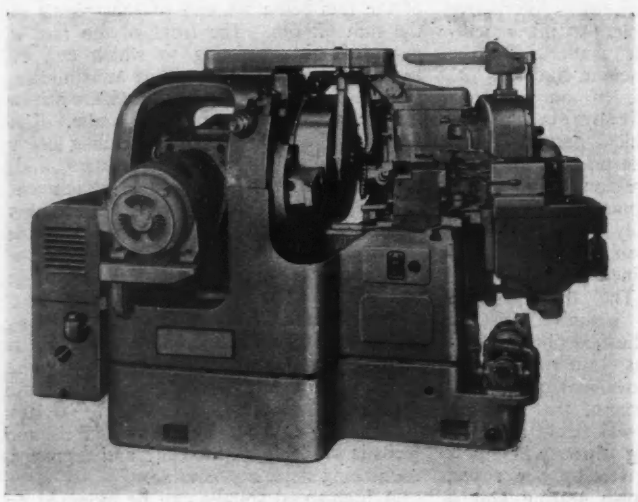
As the machine can be arranged for plunge feeding of the hob to correct depth before traversing across a blank, a considerable reduction in hobbing time can be effected. An automatic hob shift of up to 3in fitted to the hob slide enables shifts from a few thousandths of an inch up to ½in to be made at the completion of each cycle or any number of cycles, No differential mechanism, lead screw or lead cams, are required for cutting helical gears, the direction of hob traverse is simply inclined to the work axis at the same angle as the helix angle required on the gear.

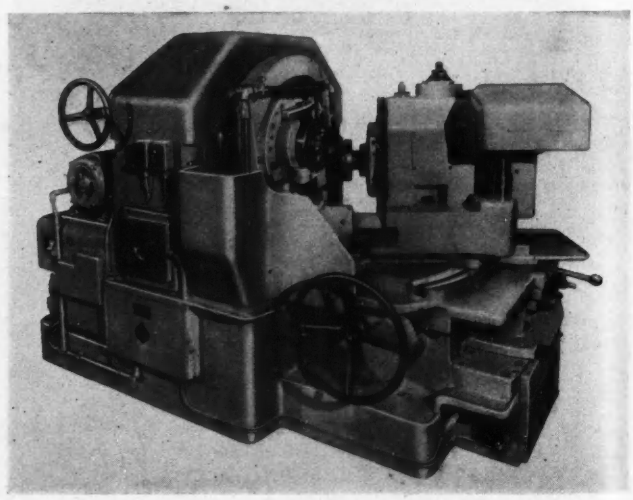
Two models of this firm's new automatic shaving machine, one of which is shown in Fig. 9, have capacities for gears up to 7in and 12in diameter, respectively, and 4 D.P. These machines take cutters from 6in to 10in diameter up to 2in wide, the maximum cutter traverse being 5in. They are designed for the rapid shaving of spur and helical gears and involute splines by the radial loading method, employing the crossed-axis principle. An interesting point in the construction of these machines is that they are capable of applying three separate forms of shaving technique—the axial, the oblique or the tangential traverse methods. When axial traverse is applied the shaving cutter is traversed in a direction parallel to the work axis. In the oblique traverse method the line of cutter traverse is inclined at an angle to the work axis, reducing the length of travel for each pass of the shaving cutter, and thus giving a corresponding reduction in shaving time. In addition, the point of closest contact moves across the face of the cutter during the shaving operation, to give an even distribution of wear. With tangential traverse the cutter is traversed at right angles to the work axis, and the makers point out that in cases where the face width of the cutter must exceed that of the work, this method reduces cutter traverse, saves shaving time and prolongs cutter life by virtue of the even distribution of wear. Since cutter runout is restricted to a minimum, this method is particularly suitable for shaving gears having shoulders adjacent to the gear teeth.

If required, the machines can be arranged for automatic loading of work blanks. The automatic machining cycle is started by depression of a single push-button after loading. In the sequence of operations the hydraulic pump and coolant pump motor, cutter drive motor and cutter traverse motors start; the cutter then in-feeds from loading position until it meshes tightly with the work gear; a further predetermined amount of automatic in-feed takes place at the point of cutter traverse reversed at each end of the stroke (in addition to the cutting strokes, this operation may include a number of idling passes as required); finally, the cutter head withdraws to the loading position and the machine stops.

The number of passes per gear is controlled by a counting device which enables the operator to select the most suitable number for any given workpiece. A separate controlling mechanism sets the number of automatic in-feed movements required in the cycle. Where required, the automatic in-feed can be eliminated to permit hand operation through a handwheel at the front of the machine. When desired, the machine can be set for fixed centre distance shaving, automatic in-feed being applied from the loading position to engagement of the cutter with the work gear.

The largest of the new machines shown by the David Brown Machine Tool Division is the firm's "PH30" automatic production gear hobber, a moving table type machine for the high-speed cutting of spur and helical gears up to 30in diameter. This machine has a fully automatic cutting cycle, although, if required, it can be supplied for manual operation and used for generating small batches of spur and helical gears, sprockets and spline shafts. Its hob slide has a vertical traverse of 16in and the machine can be used with hobs up to 5½in diameter, 6in long. The hob spindle is driven by a variable-speed unit giving a stepless range of speeds from 45 to 270 r.p.m. There are two ranges of hob feeds from 0·016in to 0·25in per table revolution and 0·011in to 0·167in per table revolution, the infeed rate ranging from 0·005in to 0·045in per revolution.





**Figs. 7 and 8—(Left) Spiral bevel and hypoid gear roughing machine for gears up to 13in diameter, 3·5 D.P.—Brown (Right) Spiral bevel and hypoid gear generator for gears up to 18in diameter, 2·5 D.P.—Brown**

During the past few years this company has developed a range of spiral bevel and hypoid gear machines which has hitherto been obtainable only from overseas. These machines include the " B17 " testing machine for spiral bevel and hypoid gears up to 20in diameter; the " B.11 " roughing machine for gears up to 13in diameter, 3·5 D.P., and the " B.16 " generating machine for gears up to 18in diameter, 2·5 D.P., which are exhibited. Other new machines in this range which are not exhibited are the "B.27 " testing and " B.27 " lapping machines for 30in diameter gears, and the " B.11 " finishing machine for gears up to 13in diameter, 3·5D.P.

Fig. 9—Production gear shaving machine with automatic loading and operation. These machines are capable of applying axial, oblique or tangential traverse shaving methods—Brown

Designed as complementary machines, the " B.11 " roughing and finishing machines are capable of high-speed production of spiral bevel, zero spiral angle and hypoid gears. Both machines are fully automatic in operation, the cutting cycle being controlled by a single push button.

In the case of the rougher, the cutting action does not employ the generating principle; gashes are cut by means of a simple depth feed of the cutter into the workpiece. On this machine a spring-loaded, quick-release clamp plate locks the gear in position, the locking spring being compressed hydraulically to unclamp the work. When cutting, the work spindle is locked and is automatically released for indexing after the cutter is withdrawn from each completed gash. The capacities of this machine (Fig. 7) are as follows :—Cone distance, up to 6½in; pitch angle, 82 deg. 52 min. (maximum) to 45 deg. (minimum); pitch line diameters, from 13in (at 8 : 1 ratio) to 8½in (at 1 : 1); pitch, up to 3·5 D.P.; face, up to 1½in; teeth in index range, 30 to 78; feed (in seconds per tooth), 4·4 to 16·2; cutter speeds, from 103ft per minute using a 9in cutter up to 188ft per minute using a 12in cutter.

On the complementary finisher the cutter has formed blades, so arranged as to finish one tooth space per revolution. Since these spaces are finished by successive cutter blades, each set to a slightly different radial dimension, a gap is left between the first and last blades to allow for indexing, which takes place as the gap coincides with the face width of the gear. Since the method of cutting is a forming process, true generation is eliminated, the mating pinion being generated to suit ensures correct contact marking.

The " B.16 " generator (Fig. 8) is a universal machine suitable for both batch and quantity production of spiral bevel, zero spiral angle and hypoid gears. On this machine the cutting cycle is fully automatic. The gear blank is fed to full depth with the cutter at the lowest point of generating roll, and both flanks of each gear tooth are generated by rolling with the cutter. The blank is then withdrawn and indexed one tooth space during the down-roll of the cutter. This precise relative rolling motion combines rotation of the cradle which carries the cutter with rotation of the gear blank on its axis.

This generating machine has the following capacities :—Cone distance, up to 9in; pitch angle, 84 deg. 18 min. (maximum) to 5 deg. 42 min.; negative root angle, 8 deg.; pitch line diameter, 18in (at 10 : 1 ratio), 16in (at 2 : 1), and 12½in (at 1 : 1); tooth depth, up to ¾in; cutters, 6in, 9in or 12in diameter.

The " B.17 " testing machine is designed for use with straight bevel, spiral bevel, zero spiral angle, and hypoid gears up to 20in diameter with axes set at 90 deg. On it the gears are run in pairs to check size, run-out, smoothness, quietness and contact markings. Variable loading is applied by a hand-operated braking system and observation of the gears can be carried out under related operational conditions. These tests can be applied (*a*) to establish correct settings on the gear-cutting machines before quantity production begins, (*b*) to ensure uniformity of quality during production, (*c*) to determine the best running position of finished gears.

### George Richards and Co., Ltd.

The largest of the three " Electrabore " horizontal boring, milling, drilling and tapping machines exhibited by George Richards and Co., Ltd., Broadheath, Altrincham, Cheshire, is illustrated in Fig. 10. This wide bed model of the No. 5 machine has a 5in diameter traversing spindle and a facing head which will face up to 54in diameter. Its 11ft by 6ft main table and wide bed suit the machine for large and heavy workpieces. The bed is 10ft wide and sufficiently long to admit 13ft 6in between the facing slide and boring stay.

A new design of upright fitted on the improved machine has been considerably enlarged from front to back to accommodate the balance weight, which now moves vertically inside the upright. The weight provides an even balance for the spindle frame, and relieves the vertical traverse screw from undue pressure and facilitates hand adjustment to the spindle frame. As on previous machines, the upright is provided with the firm's design of prismatic slide, by which cutting forces are distributed over a large area. When the machine is used for intermittent cutting or heavy duty, the construction of the slide ensures steadiness and accuracy.

The main spindle of high-carbon steel has a solid flange to which the facing head is rigidly bolted. It is mounted in Timken taper roller bearings in a redesigned spindle frame, and the bearings are set well apart to ensure rigidity when using long snout tools or milling cutters.

The drive to the main spindle is transmitted through an endless precision-ground bush roller chain. The chain wheel is mounted on an independent sleeve which is carried in radial bearings, thus relieving the main spindle of all load from the driving chain.

The facing head has twenty-four speeds,

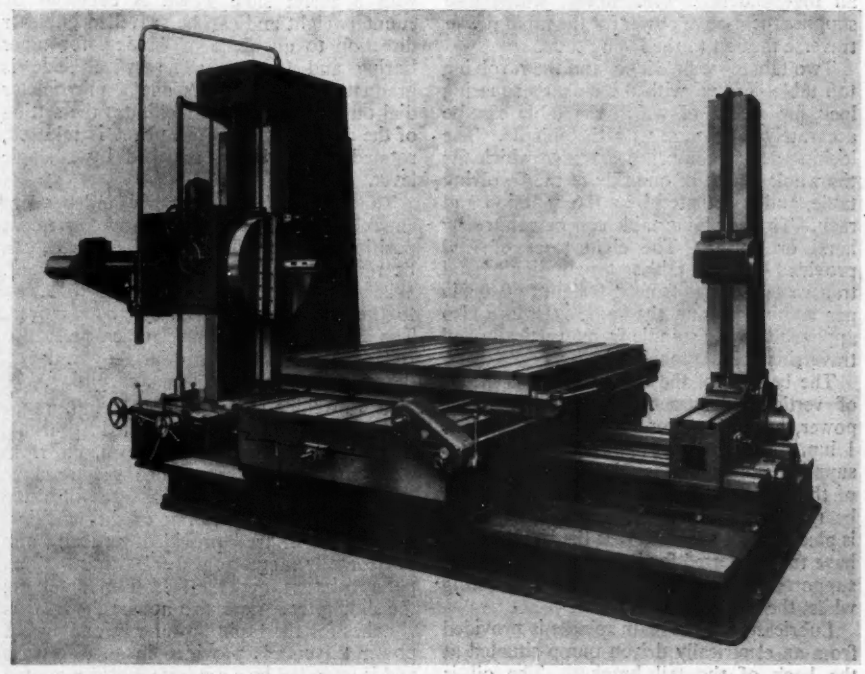


Fig. 10—Wide-bed " Electrabore " horizontal boring, milling, drilling and tapping machine—Richards

ranging from 1·66 to 130 r.p.m., and is bolted directly on to the main spindle flange. The totally enclosed mechanism in the head provides eight reversible feeds to the tool slide, ranging from 0·01in to 0·125in per revolution. These feeds are continuous and are controlled by a single lever. Rapid power traverse is provided to the facing slide.

The traversing spindle has thirty-six speeds ranging from 1·66 to 300 r.p.m., and the rapid power traverse provided is driven by an independent 3 h.p. motor, which also supplies the motive power for the rapid power traverse motion to the facing slide.

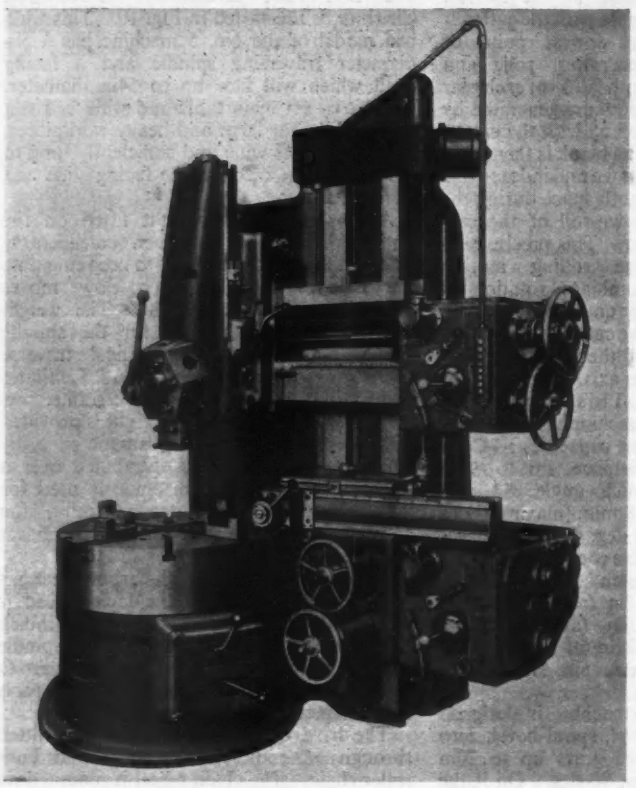


Fig. 11—36in "Victor" rapid production boring and turning mill—Richards

Two tables are provided, and the revolving top table is fitted with the maker's squaring lock, by means of which the table can be accurately set square with the spindle. The locking device comprises a wedge which fits the whole length of one side of the revolving table, and is actuated by a lever, pinion and rack. The revolving table can be rotated by hand or power. The eight rates of feed provided for the tables, longitudinally and transversely, range from 0·0005in to 0·063in per revolution, and the same rates are also applicable to the spindle frame vertically and traversing spindle longitudinally.

The bearing of the boring stay has means of vertical adjustment either by hand or power, and for power movement a separate 1 h.p. motor is provided. This motor also supplies power for longitudinal movement of the boring stay along the bed. The stay bearing has a hinged cap, the joint of which is placed at an angle, so that the bar does not have to be inserted for its full length and it is supported on the lower portion of the bearing whilst the cap is being secured.

Lubrication to the main spindle is provided from an electrically driven pump situated at the back of the tail bracket. The oil is passed through a filter and oil sight glass to the bearings, and then returned to the sump.

A Tecalemit hand-operated pump is used to lubricate the bed mechanism and the tables and saddles.

In addition to the rapid power traverse to the facing slide and traversing spindle, previously mentioned, rapid power traverse driven by a second independent motor is provided for all other sliding units, which also have a means of slow-traverse motion. Illuminated optical projectors are fitted to the upright and boring stay, and to the cross and longitudinal traverses to the table, to facilitate the accurate positioning of these units. A screw-cutting arrangement provided for the table is capable of cutting Whitworth threads from two to sixteen per inch.

This firm is also exhibiting one of its 36in "Victor" rapid production boring and turning mills (Fig. 11). This machine admits work up to 44in diameter with the side head set below the top of the table and 38in with the head in its working position. Work up to 42in high can be admitted below the turret, which has a vertical movement of 24in and a horizontal movement of 24in. The side head turret can be moved over a vertical height of 30in and has a horizontal traverse of 17½in.

The main body of the machine is a single substantial casting of box formation, strongly reinforced by internal ribbing. It is fitted with a turret slide which is balanced by counterweight and can be swivelled in either direction to an angle of 45 deg. for taper boring and turning. The swivel slide is graduated on both sides and a micrometer dial on the worm shaft facilitates the setting of the desired angle. The turret is released, rotated, indexed and relocked by a single lever.

The jaws of the four-jaw independent chuck table can be placed in any convenient position on their slides and, if required, can be reversed to suit the shape of the work. When it is preferable to bolt work direct on to the table top the jaws can be removed. The table is mounted on Timken preloaded roller bearings and is driven by a large-diameter external spur gear and pinion.

The machine is driven by a 35 h.p. motor through a mechanically-operated gearbox, and twelve table speeds are available from 12·5 to 250 r.p.m. Speed changes are made through sliding gears, which are operated by two levers at the front of the machine. Eight rates of feed provided vertically and horizontally range from 0·0034in to 0·135in per revolution, and the feed box containing the sliding feed gears also houses the friction clutches for the rapid power motion. Rapid power traverse is provided in all directions and is operated by a separate motor mounted at the foot of the column. A "joystick" control is provided to the rapid power traverse motion, and the motion is interlocked with the feed mechanism to obviate simultaneous engagement.

Means of fine hand adjustment is provided through handwheels with reference to index dials, and rules and verniers are fitted to the vertical movement of the turret slide and the horizontal movement of the saddle to facilitate positioning.

The main motor cannot be started until the lubricating oil pump motor supplying the main bearings and driving gears is in operation. All the feed gearing in the box on the end of the cross slide is splash lubricated from a reservoir in the bottom of the box, and splash lubrication is also applied to the main driving gearbox, which is a totally enclosed unit and situated at the rear of the machine. The cross slide is elevated by a separate 3 h.p. motor mounted on top of the machine.

The side head is an entirely independent unit and is mounted directly on the column slide. Its slides are long and narrow, and taper gibs are provided for maintaining correct relationship between bearing surfaces. The slides to the side head ram are of the square lock design with means of taper gib adjustment. The side head tool bar does not swivel, but is provided with four-sided steel revolving toolholder, which is released, rotated, indexed, and relocked by a single lever. The head is balanced by a counterweight enclosed in the column. It has eight rates of feed from 0·0034in to 0·135in per revolution, and these feeds, which are entirely independent of those to the turret head, operate in both the vertical and horizontal directions.

A 6ft double standard vertical boring and turning mill exhibited is fitted with hydraulic contouring equipment. This equipment is applied to the vertical movement of the ram, a piston coupled to the ram and the cylinder being mounted on top of the spring balance column. A stylus-operated hydraulic pilot valve, mounted on a compound slide, is attached to the face of the ram and this valve controls the flow of oil to the operating piston and cylinder. The stylus of the pilot valve unit is spring loaded to bear lightly upon the profiled edge of the stationary master template.

In operation, a steady horizontal feed is applied to the head by means of the normal cross traverse feed screw, the angled ram, actuated by the operating piston and cylinder, follows the profile under the control of the pilot valve. This contouring equipment does

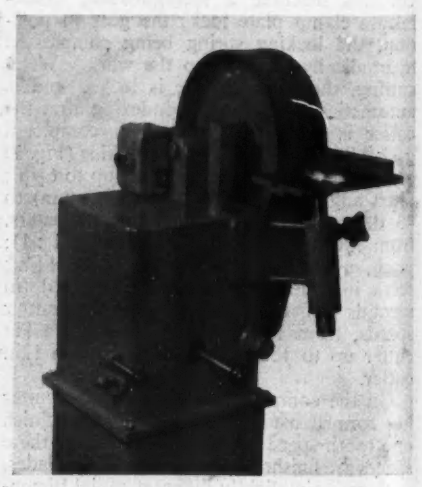


Fig. 12—"Toolmaster" abrasive band lapping machine for carbide tools—R. J. H.

not prevent the head being operated in the normal mechanical manner, both vertically and horizontally.

This machine is also equipped for constant cutting speed and the control for this device is electrically operated in conjunction with the main driving motor. On it predetermined constant cutting speeds are obtained by the setting of a selector on the control desk.

**R.J.H. Tool and Equipment Company, Ltd.**

The grinding and polishing machines shown by the R.J.H. Tool and Equipment Company, Ltd., Artillery Street, Heckmondwike, Yorks, include one of the firm's "Toolmaster" abrasive band carbide tool lapping machines. This pedestal mounted machine (Fig. 12) is designed to use silicon carbide, paper-backed bands for tool lapping purposes.

The 4in wide, 54in long abrasive band is mounted between the driving pulley and a 13in diameter contact wheel, which is driven by a 1500 r.p.m. motor. A 9in by 5in table in front of the contact wheel can be adjusted vertically to give tool rake angles from −5 deg. to +20 deg. A graduated holder plate on which the tools are held on the table can be set to give the other required cutting angles. The belt is tensioned by the weight of the driving motor, and when it is required to change a belt, the motor and its platform are raised by means of the lever projecting from the front of the machine. A lever at the side of the machine actuates a cam which tilts the motor platform for belt tracking purposes.

**Wickman, Ltd.**

More than a hundred machines are to be seen upon the stands occupied by Wickman, Ltd., Tile Hill, Coventry, and in addition to those of this company's own manufacture, there are many machines of American and Continental make. The range of automatics now made by the firm covers four, six and eight-spindle machines, for bar work up to 3½in capacity and for chuck work up to 9in ; and examples of practically all of the latest designs of these machines are shown in operation on its stands. High spindle speeds are given prominence in the demonstrations, and in one case fast production is shown on a 1in, six-spindle, automatic (Fig. 13), tooled for the production of brass adaptors, two components being produced at each indexing, in a cycle time of 1·99 seconds. On another, similar, machine, designed to feed bar in two stations, two dissimilar components in mild steel are produced in 3·8 seconds.

The company's most recently introduced 2in six-spindle bar machine is used to demonstrate the production of a special mild steel component to illustrate the tooling possibilities. The component requires the machining of seven external and four internal diameters, a rolled thread behind a shoulder, a rolled exhibition marking, a tapped thread, and facing and ending to length. The set-up comprises fourteen tools and the cycle time is 9·6 seconds. This machine has a bar-feed capacity from ½in to 10in, a spindle speed range of 111 to 1302 r.p.m., and cycle times from 7 to 602 seconds. The largest of the three chucking automatics shown is the 9in four-spindle machine, illustrated on one of the accompanying Plates. This machine is demonstrated machining a front hub involving a multiplicity of tooling and close tolerances on several dimensions. It is available with two spindle speed ranges from 28 to 363 r.p.m. or 43 to 554 r.p.m., with respective cycle times from 17·7 to 1968 seconds and 13·8 to 1315 seconds.

The Wickman $\frac{7}{16}$in sliding head precision automatic is designed for the production of accurate small turned parts, usually of the long, slender character required in the clock and precision instrument industries. In it bar stock is fed by the sliding headstock past five radially disposed cutting tools, each individually controlled by cams which transmit the required tool feed movements. Supplementary attachments for threading, drilling, screw-slotting, cross-drilling, flat milling, taper turning, and back-machining, can be applied during the normal machine cycle. It will be shown producing an arbor 1¾in long and the operations include the turning of six diameters and two radiused grooves, a long taper, a pivot point at the rear end, a drilled hole at the front end and a threaded length. The five radial tools do the turning ; a three-spindle attachment does the centre drilling, drilling and button die threading ; then a pick-up arm descends and supports the component whilst the pivot point is turned and parting-off takes place. A piece is completed in 33½ seconds and the tooling and set-up can be seen in Fig. 14.

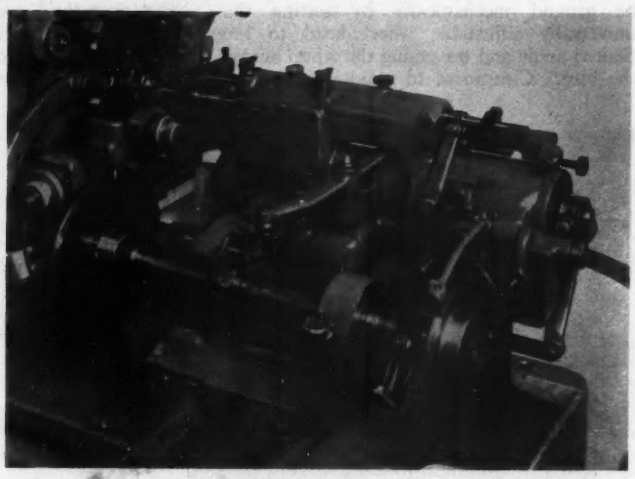


Fig. 14—Three-spindle attachment on the $\frac{7}{16}$in capacity sliding head precision automatic—Wickman

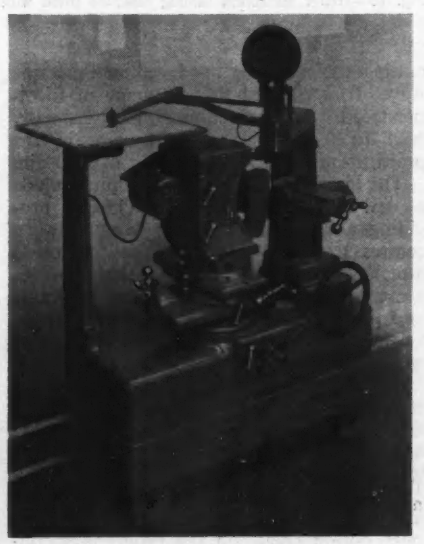


Fig. 15—Optical profile grinding machine—Wickman

The optical profile grinding machine introduced by Wickman, Ltd., some years ago, now incorporates a number of new developments which increases its range of application. On this machine, shown in Fig. 15, profiles are ground by optical reference to a master drawing fifty times larger than the form to be produced. A microscope and

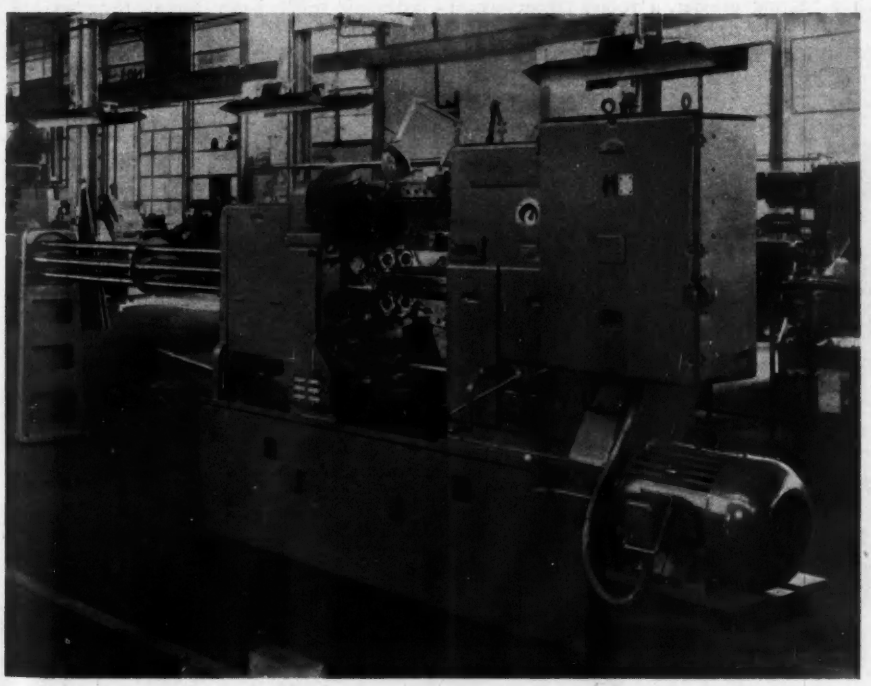


Fig. 13—Six-spindle, 1in bar automatic—Wickman

screen projection unit mounted in the final arm of a 50 : 1 pantograph are positioned over the work in precise relationship to the drawn profile. Grinding of the form then proceeds by traversing the reciprocating grinding wheel to the centre of the cross hair lines of the graticule in the microscope or screen field. Regular angles in the form can be ground mechanically by setting the universally adjustable wheel head to the desired angle and traversing the wheel across the face. Clearances to maintain form on cutting tools can be produced in the same way. It is claimed that accuracy of forms produced on the machine can be generally held to 0·0005in and, with care in the preparation of the 50 : 1 drawing, to 0·0002in.

Fig. 16—Heller horizontal milling machine fitted with automatic control equipment—Wickman

The improvements on the machine include a new circular grinding attachment providing a means for holding work between centres or in a chuck. A new indexing attachment, when fitted on the table, provides a means of securing press tool die segments and punches requiring form grinding in the vertical plane, and indexing for all round working, if required.

An end-cutting form tool indexing attachment now provides means of universal adjustment to any angle or combination of angles, for grinding small end cutting tools up to ¾in diameter shank.

Amongst the German machines of interest are the Heller milling machines, which have push button operation and programme control. The horizontal miller is shown in Fig. 16. In these machines all feed movements of the table are hydro-mechanically operated and a separate hydraulic motor used for each movement drives its feed screw through suitable reduction gearing. The push buttons and rotary switches used for controlling the machine are conveniently grouped on a panel at the front of the knee. Immediately below the inclined control panel are the rotary switches for varying the feed and speed rates of the various movements. Tell-tale lights built into the push buttons are illuminated as they are depressed and the movement called for only commences when the corresponding push button is released. Slides fitted with cams on the table, saddle and knee actuate switches for the automatic control of the machine. These cams are clearly marked for rapid traverse, feed, reduced feed and stop, and may be locked without interference in the separate tee slots for all directions of movement.

For automatic cycle work several kinds of programme control can be supplied for the machine. For machining large and medium work batches use can be made of a controller with rotary switches with pointers which are set to the desired sequence. This controller enables the machine to be set for a programme with up to ten changes of direction. Another controller permits frequent changes in the programme, and is suitable for the production of small batches. The cycle is registered by the operator, who presses the push buttons for the various movements and speed changes in correct order. After completion of a batch the programme may be cancelled, when the selector switches return to zero position and are available for the registration of a new programme.

In another controller developed for mass production of one or several components the actual programmes are produced by connecting the circuits through mult-pin plugs, which are wired to obtain the desired sequence.

The group of Naxos-Union grinding machines exhibited includes a crankshaft line bearing grinder, a rotary table vertical spindle surface grinder, and a universal cylindrical grinder for work up to 13in diameter and 44in between centres. This universal machine is claimed to be particularly versatile, due to the range of angular movements provided to the wheel head, work head and upper table. The positions of the work head and tailstock can also be transposed to provide a wide working range, and the work head can be swivelled through a full 360 deg. Both plunge grinding and traverse grinding can be carried out, and by swivelling the grinding head through 90 deg. flat faces at right angles to the table axis can be ground.

One of the two Dubied copying lathes exhibited is fitted with equipment which gives a constant cutting speed, irrespective of the diameter of the work being machined. The control of the hydraulic feed system of the machine is mechanically connected to the main spindle and gives a constant feed per revolution of the work. Schaublin high-precision machines to be seen upon one of the Wickman stands include representative types of milling machines, turret lathes and tool-room lathes. The Hauser equipment shown includes two types of that firm's well-known jig borers, an optical jig grinder, a pivot burnishing machine, a two-spindle profiling machine for watch parts, and a profile projector.

### Kendall and Gent, Ltd.

The heavy machine tools made by Kendall and Gent, Ltd., Hyde Road, Gorton, Manchester, include a plano-milling machine, illustrated on one of the accompanying Plates, a special-pupose duplex horizontal milling machine, and the recently introduced openside milling machine, shown in Fig. 17. This machine is fitted with two milling heads, each driven by its own 20 h.p. motor, one on the upright and one on the cross slide. The vertical head can be adjusted up to 5ft 6in from the upright slide along its arm, and the maximum distance the horizontal head spindle axis can be set above the table top is 2ft 9in. The table is 11ft long and 4ft wide and has a traverse of 13ft 6in.

To simplify control and correct feed selection on this machine a system of electro-hydraulic transmission for all traverses has

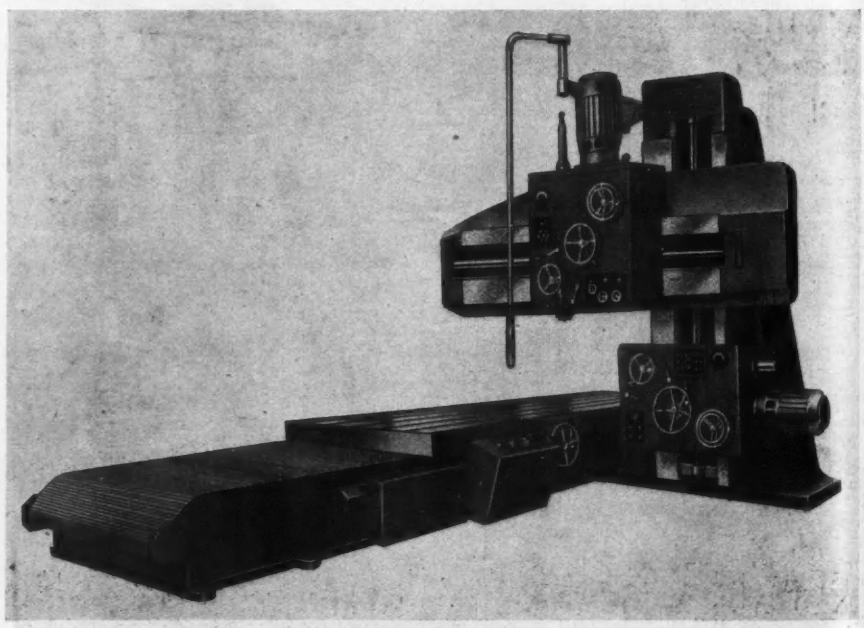
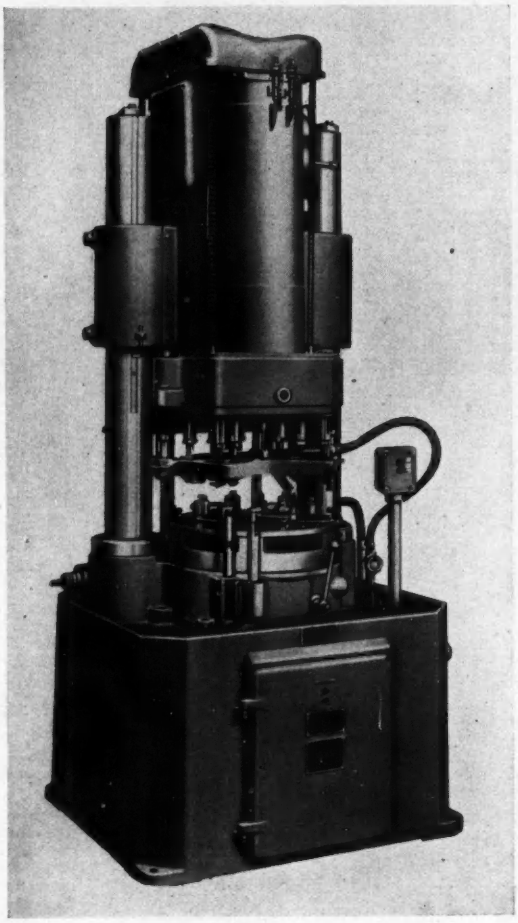


Fig. 17—Open-side milling machine with electro-hydraulic transmission for all traverses, giving stepless feed rates—Kendall and Gent

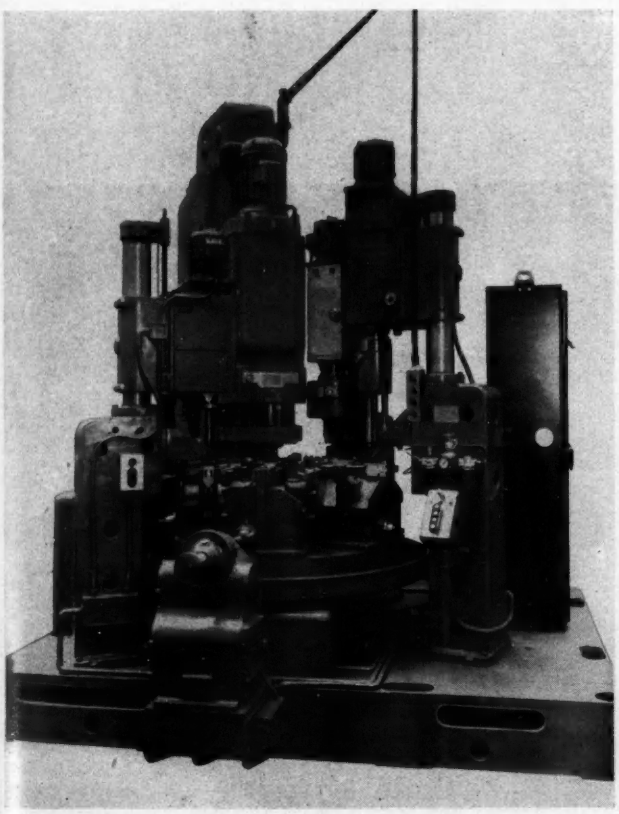
# SPECIAL PURPOSE MACHINE TOOLS

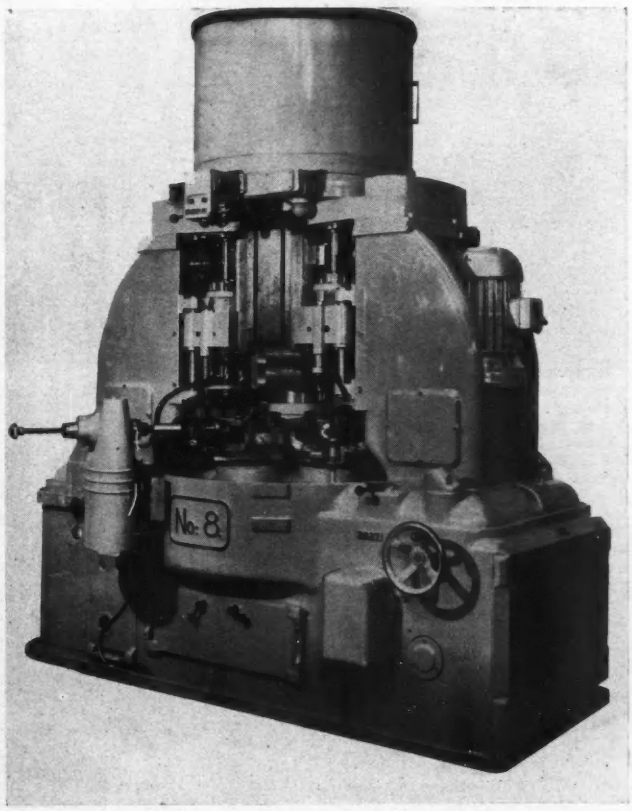
A number of multi-head transfer machines are exhibited at Olympia engaged in typical machining operations on automobile parts. Three of these high-production, automatic-cycle machines, which are illustrated on this plate, are generally of their makers' standard designs. One of the machines, the twin-column rotary transfer machine (right), is a standard Adcock and Shipley machine with an automatic indexing column. It is exhibited with fixtures and a multi-spindle drill head for the core drilling, rough and finish reaming operations on a Vauxhall steering shaft bracket and its multi-head is fitted with nine spindles. It is working on a ninety-nine-second time cycle, during which three components are produced. The four-station table of the machine is indexed by a Geneva motion through reduction gearing driven from the head. An interlocking mechanism is fitted to prevent the table being indexed until the loaded components have been clamped.



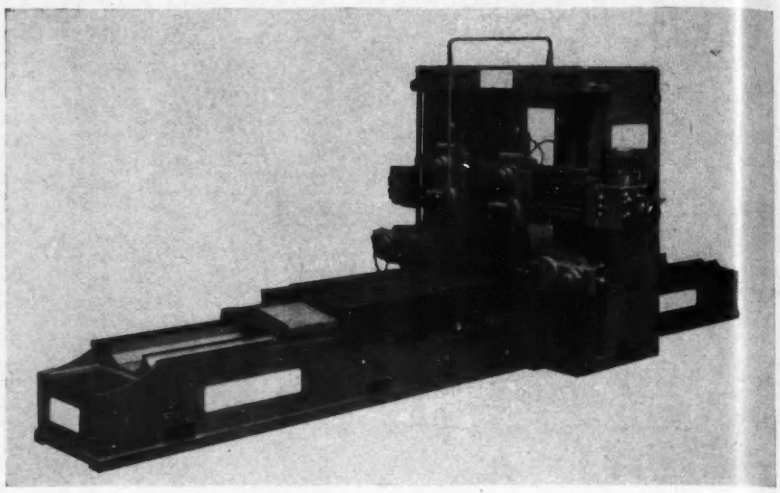
The five-station vertical multi-head machine below (left) is exhibited by Wm. Asquith, Ltd., and is arranged for drilling, reaming, tapping and chamfering automobile exhaust manifolds. Its rotating table is automatically indexed by a hydraulic motor through bevel gears and a spur gear bolted to the table.

One of the machines on the stand of Thomas Ryder and Son, Ltd., is the "8 T Vertical-auto," illustrated below (right), which has been modified as a rotary transfer machine with fixtures fitted on the indexing table in place of six of the revolving work spindles. Each fixture carries four components and the machine is tooled up for machining malleable iron rear hub castings. Its turning slides are fitted with tool heads carrying revolving spindles and the heads at stations six, seven and eight are equipped for drilling, tapping and reaming the holes in the hub flanges.

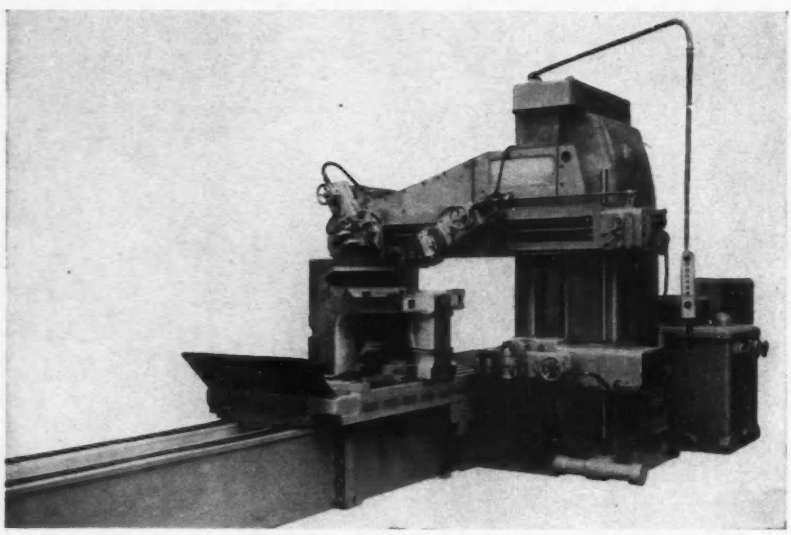




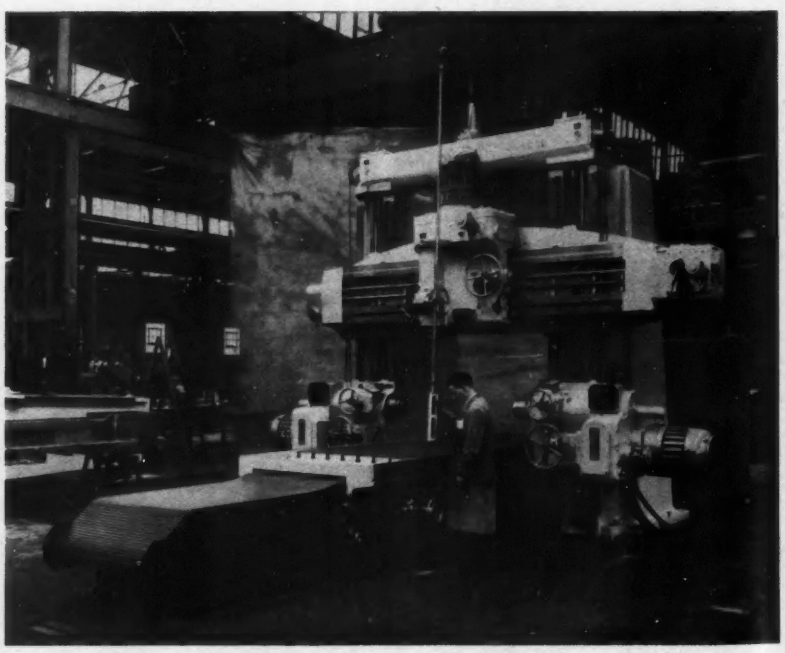
# PLANING AND BORING MACHINES



The planing machine (right) made by Swift Summerskill, Ltd., of Halifax, is designed to admit work 4ft wide, 3ft 6in high between the uprights, and will handle parts up to 8ft long. It has two toolboxes on the cross slide and one on each upright. A 25 h.p. reversing motor used for the main drive gives table speeds continuously variable from 25ft to 200ft per minute. Eighty feed rates, which are available, range from 0·005in to 0·450in per stroke, and a quick power traverse is provided for all the usual motions. Centralised and pendant push-button controls are provided.



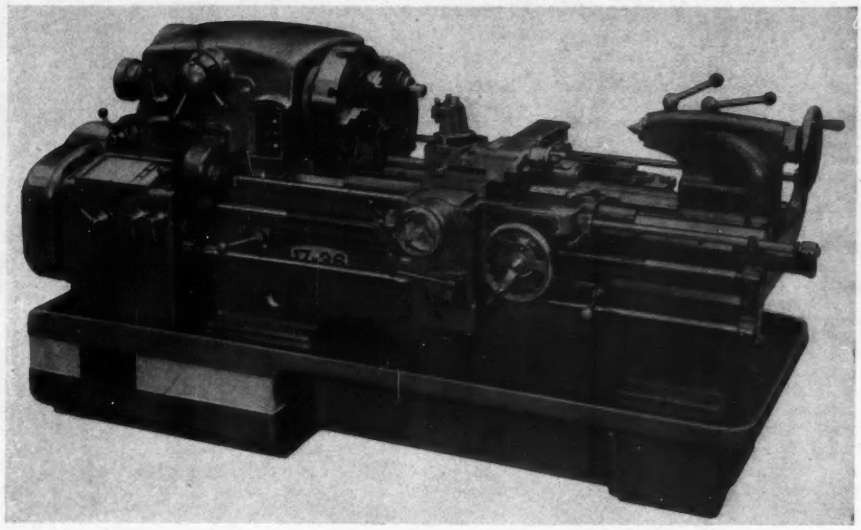
The Waldrich open-side planing machine illustrated on the left is exhibited on the stand of Drummond-Asquith (Sales), Ltd. It has a planing capacity for work up to 59in wide by 47in high, and is equipped with two toolboxes on the cross slide and one on the column. All motions on this machine are hydraulically operated and the separate housing of the hydraulic supply system, which also serves as an oil reservoir, incorporates the pump and the controlling, regulating and feed indexing mechanisms. The table is fully supported over its entire working length and is actuated by a hydraulic piston and cylinder. Each of the toolboxes can be swivelled through a wide arc to suit the class of work, and is arranged for automatic tool lift on the table return stroke. A stepless range of feeds and rapid traverse is available in both the horizontal and the vertical movements of the machine.

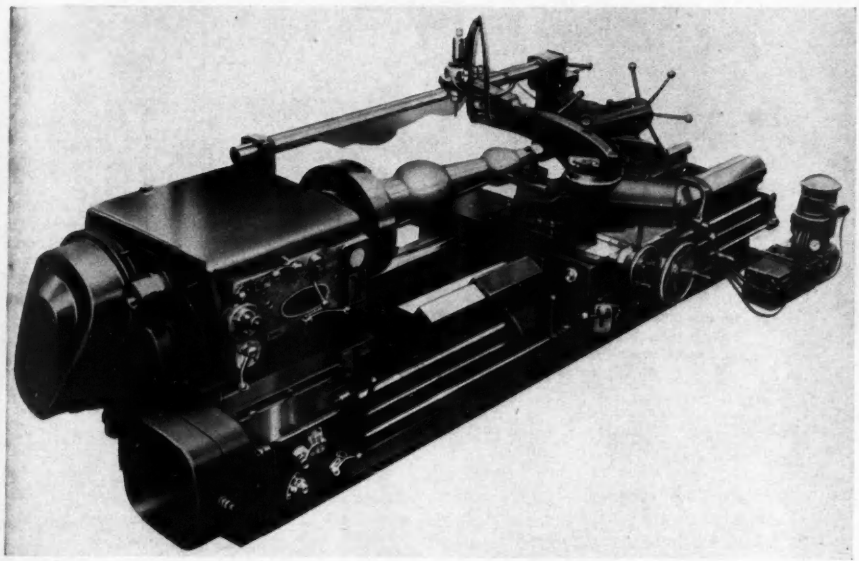


The plano-milling machine (right) is one of the medium capacity machines made by Kendall and Gent, Ltd. Its table has a 5ft wide, 14ft long working surface and is driven by an independent 7½ h.p. motor through an eight-speed gearbox, giving feeds from 1in to 12in per minute. Each of the milling heads is driven by a 15 h.p. motor and has sixteen spindle speeds from 15 to 285 r.p.m. These heads can be traversed along their slides by power feed and rapid traverse, and the eight rates of feed range from 1in to 12in per minute. Through a simplified control mechanism all movements of the table are regulated by duplicated joystick levers on each side of the bed and by a pendant push-button box. Controls for the milling head traverse movements are grouped on the ends of the cross slide.

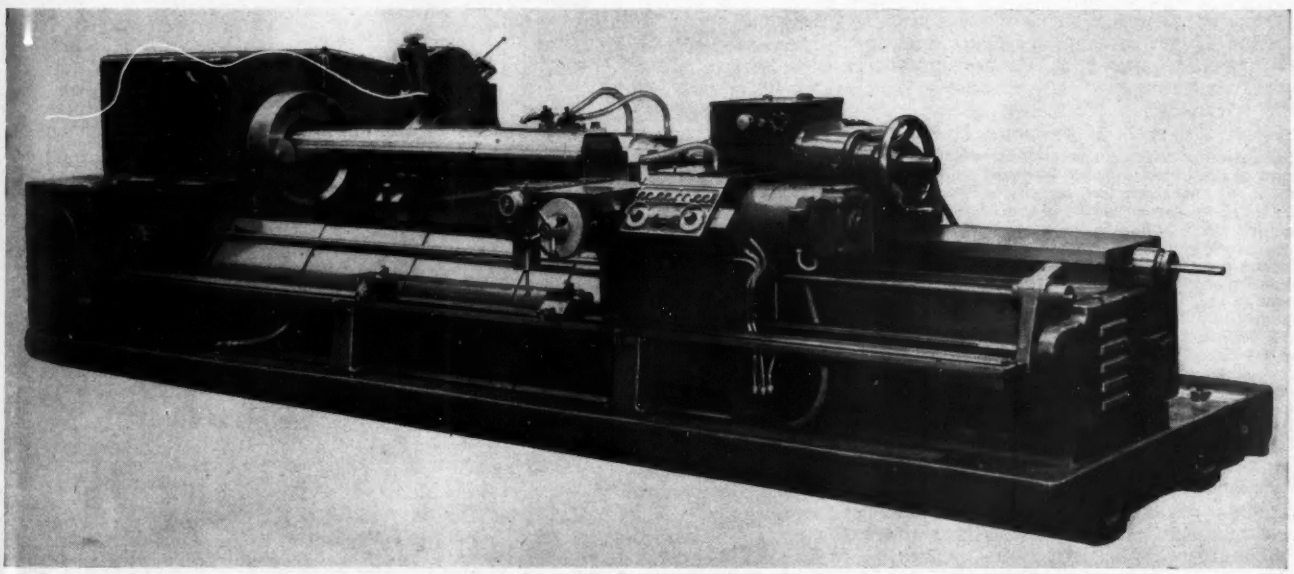
# TOOLROOM AND COPYING LATHES

The toolroom lathe (right) made by Dean, Smith and Grace, Ltd., has a swing of 18in diameter over the bed and is made with two bed lengths to take 36in or 48in between centres. Its headstock is driven through vee-belts by a two-speed 7½/3¾ h.p. motor and a self-adjusting multi-disc clutch. The thirty-six forward (3·9 to 720 r.p.m.) and twelve reverse (6·9 to 720 r.p.m.) spindle speeds are selected by levers and a direct reading dial. In a totally enclosed, multi-change gearbox changes are selected by a rotating knob and two ratio levers. It gives forty-eight sliding feeds from 14 to 800 cuts per inch, forty-eight surfacing feeds from 28 to 1600 cuts per inch, and a screw-cutting range from 2 to 112 threads per inch. A taper turning attachment can be used for machining tapers up to 15in long, and a relieving attachment forms an integral part of the machine. The relieving gears cover work having up to twenty flutes, and special change gears can be used for relieving spiral fluted hobs.



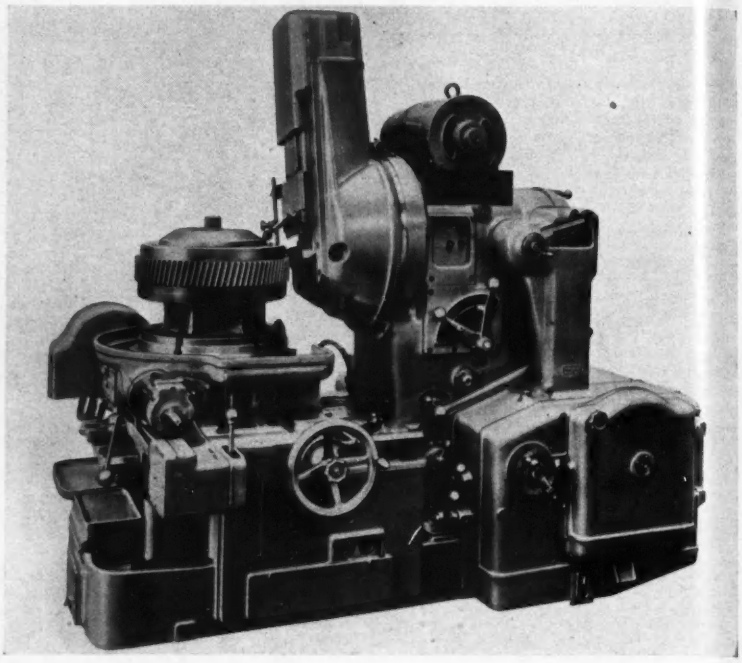


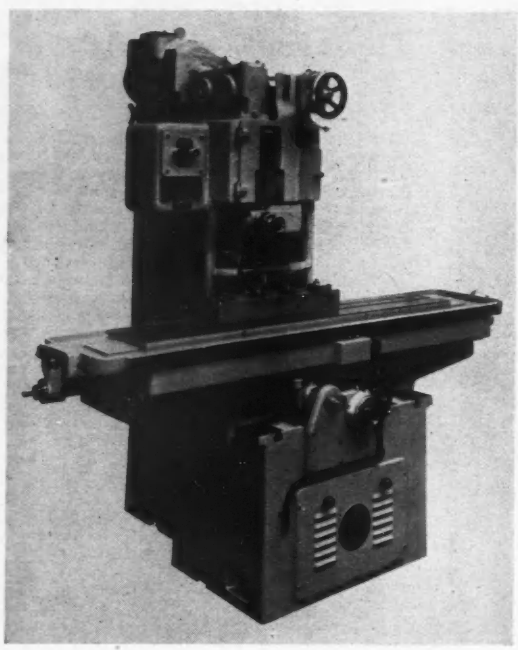
The lathe fitted with copy turning equipment (left) is made by George Swift and Sons, Ltd., and has a 15ft gap bed to admit up to 8ft 3in between centres. This machine swings 33in diameter work over the bed and 22¼in diameter over the saddle. It is driven by a 30 h.p. reversing motor and has eighteen spindle speeds from 8·5 to 500 r.p.m. An ammeter is fitted to show the current being consumed and a tachometer shows the speed at which the spindle is running. The machine has the usual sliding, surfacing, screw-cutting and top slide feed motions, and the nine sliding feeds range from 10 to 300 cuts per inch. The normal screw-cutting range is 1 to 80 threads per inch but, when the coarse pitch screw-cutting motion is engaged, leads up to 10in can be cut. Interchangeable with the standard bolt and plate slides are a set of hydraulic forming motion slides, the template for the forming motion being carried at eye level at the rear. The machine illustrated below is one of the well-known Drummond "Maxicut" lathes fitted with electronically controlled copying equipment.



# GEAR AND RACK CUTTING MACHINES

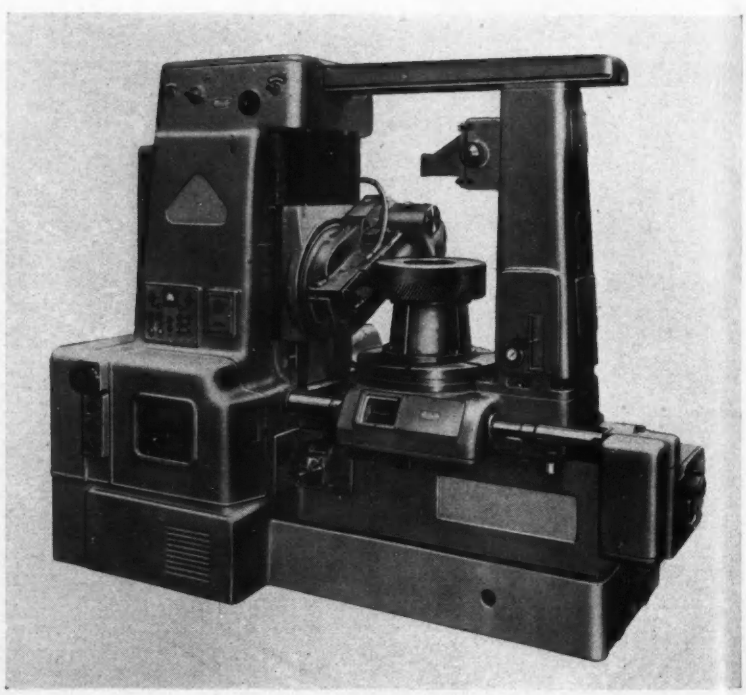
The Maag gear-cutting machine (right) is exhibited on the stand of Burton, Griffiths and Co., Ltd., and is designed to cut spur or helical gears of 29½in maximum diameter. It uses a rack-shaped cutter which cuts on the down stroke in a motion parallel to the tooth flank. The generating motion takes place on each cutter return stroke and is a combined straight and a revolving movement performed by the worktable under the control of change wheels. The cutter used is of limited length and during the machining cycle the blank is periodically returned to its initial position relative to the cutter. During the return motion, the worktable moves backwards parallel to the tool, which remains at the top of its stroke. The workpiece does not rotate during this operation and a dividing motion is carried out automatically as the gear blank is advanced one or several tooth spaces relative to the cutter. The return motion is followed by a short backward and forward rolling of the worktable, which takes up the play in the driving mechanism for the generating and dividing motions. After the tooth height or cutting depth has been set on the machine the automatic generating and feed motions are continued until the gear has been finished and the machine stopped automatically.





The vertical rack generating machine (left) is a product of W. E. Sykes, Ltd., and is exhibited cutting a 48in long rack of 3in by 2in section, with teeth 60 D.P. and 20 deg. pressure angle. It is designed to cut straight and helical toothed racks up to 60in long, 3in face width, and between 5 and 64 D.P. Machines of this design are also well suited for generating a variety of both single intermittent and continuous profiles on flat section material. The machine has an effective range of cutting feeds and speeds and adjustable limit switches with which it is fitted stop the machine when a predetermined length has been cut. Cutting can be performed in either direction of table traverse and it is only necessary to set the control to reverse when generating the teeth of the successive components. A vernier scale which enables the operator to "pitch in" accurately at any desired point is of special value when cutting intermittent racks.

The automatic production gear hobber (right) is the largest of seven new machines exhibited by David Brown Industries, Ltd., and it has a maximum gear capacity of 30in diameter, 16in face width and 1in circular pitch. It is of moving table construction, and has a fully automatic cutting cycle which is controlled by a single push button. The cradle, overarm support and steady bracket are all clamped hydraulically. It takes hobs up to 5½in diameter and 6in long, and the range of hob speeds available is from 45 to 270 r.p.m. The vertical hob feeds per revolution of the table are 0·016in to 0·25in in the coarse range, and 0·005in to 0·045in in the fine range, the hob infeed rates being from 0·005in to 0·045in. This wide range of hob speeds and feeds facilitates the selection of the most suitable combination for a particular workpiece and the drive to the hob spindle includes a variable-speed mechanism, which gives a stepless variation of hob speeds. If required, a universal hob slide can be fitted to enable worm wheels to be generated by the tangential feed method.



been adopted, and it provides a stepless variation in feed rates. The table has a feed range of 1in to 24in per minute, adjustable by means of a rotary valve and, in addition, a rapid power traverse of 15ft per minute is provided. The worm and rack final drive to the table, together with the hydraulic transmission, ensures a smooth vibration-free movement. Both the milling heads are traversed along their respective slides in a similar manner to the table and the 1in to 24in per minute range of feeds is steplessly variable. Rapid power traverse of 48in per minute allows the milling heads to be positioned quickly during setting. In addition to these normal traverses, each of the spindles is equipped with a steplessly variable power feed ranging from 0·25in to 6in per minute and a rapid power traverse of 12in per minute.

Hydraulic locks secure the spindle sleeves in position after the depth of cut has been set and an automatic retraction clears face cutters after finishing cuts. A semi-automatic system of operation which can be used, if desired, works in conjunction with the table trips. This operates as follows :—The operator sets the milling head in position along the slide and adjusts his depth of cut in the normal way, locking the spindle in position. The workpiece is then traversed into the cutter on the selected feed rate and a trip dog which is preset depresses a limit switch on finishing the pass. This automatically unlocks the spindle sleeve and causes the spindle instantaneously to retract a distance of 1in clear of the workpiece. The table is then rapidly traversed back to the starting point of the cut with the cutter running clear above the workpiece. Upon reaching the original position a further limit switch is depressed, which advances the spindle again to its original cutting position and automatically re-applies the sleeve lock. The spindle retraction can be operated at any time by the operator by turning a rotary switch carried on the pendant. The sixteen spindle speeds provided range from 12 to 780 r.p.m., speed selection being made by handwheel and registered on large dial. An ammeter scaled in horsepower and amperes is flush mounted into each milling head to indicate the power absorbed by any cut imposed, and to provide an indication to the operator of the condition of the cutter in use. Hand traverses equipped with micro-dials are built in the milling heads for final hand setting, and the horizontal head is partially balanced for ease of adjustment.

Hand motion to the table is duplicated at each side for the convenience of the operator and power or hand traverse is selected by hand lever adjacent to the handwheel. A desk mounted on the right-hand side of the bed carries the table feed control valve and push buttons for the starting of the main table traversing pump motor and the table slideways lubricating pump. Selection of feed or rapid traverse and directional selection is by push buttons carried on the pendant control station.

The firm's "C.V.M. 60" vertical milling machine, generally similar to the "C.V.M. 25," shown in Fig. 18, is particularly intended for using tungsten carbide milling cutters. Its milling head is driven by a 40 h.p. motor and eighteen spindle speeds from 15 to 830 r.p.m. are provided. Speed changes are effected through a single lever on the right-hand side of the head, and a simple system of symbols is used to indicate the speed engaged. The spindle centre is set 3ft from the face of the column and at maximum elevation of the head the spindle nose is 3ft 5in above the table. The head is elevated by a 3 h.p. reversing motor.

The table has a working surface 9ft long by 2ft 6½in wide, its longitudinal and transverse traverses being 7ft 2in and 3ft 3in respectively. There are eight table feeds to each spindle speed and these feeds range from 1in to 12½in per minute.

Table feeds are reversible and obtained from a horizontal end-shield-mounted, constant-speed 3 h.p. motor, coupled through suitable reduction gearing to the change feed box. The box is mounted under the left-hand end of the table with clearly-numbered direct-reading feed-change indicator projecting to the front. Direction of table traverse is controlled electrically by push buttons carried in the pendant. The feeds can be tripped by adjustable stops at any predetermined position in both longitudinal and transverse directions.

Control of all motions on this machine has been simplified so as to require only two levers and the push button pendant. One lever engages either the feed traverse or rapid power traverse, whilst the other lever selects either longitudinal or transverse traverse. Directional selection and starting and stopping are controlled from the pendant.

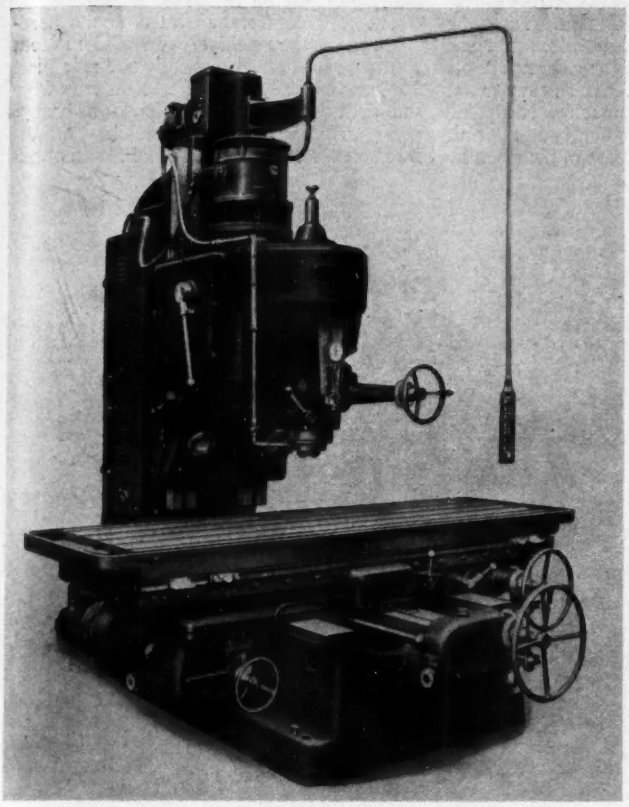


Fig. 18—Heavy-duty "CVM 25" vertical milling machine—Kendall and Gent

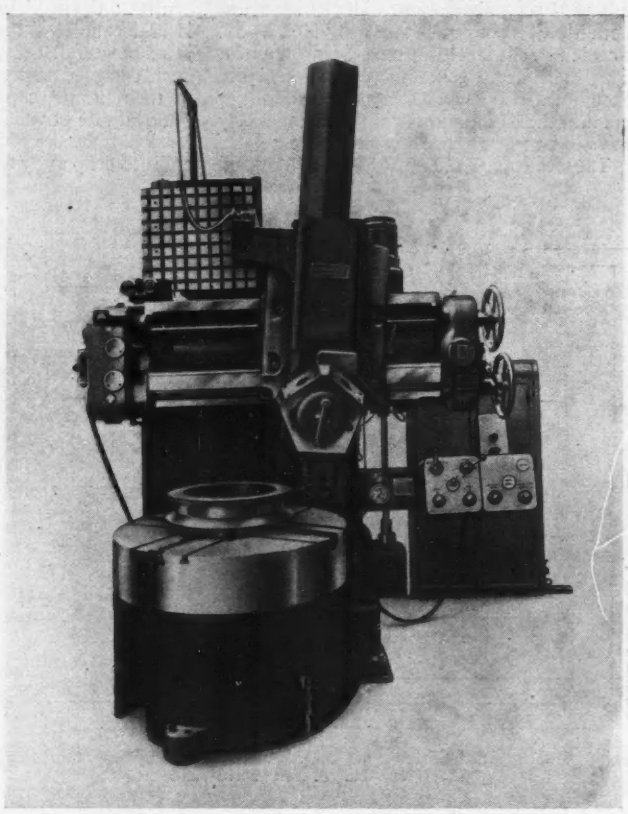


Fig. 19—48in boring and turning mill fitted with electronic profiling equipment—Webster and Bennett

### Webster and Bennett, Ltd.

One of the two boring and turning mills demonstrated by Webster and Bennett, Ltd., Foleshill, Coventry, is equipped with electronic profile turning equipment of Lancashire Dynamo and Electronic Products, Ltd., design. On this 48in machine, which is illustrated in Fig. 19, the tracing equipment forms an integral part of the mill, which can be used as either a standard hand-controlled or a tracing machine—depression of a push button effects the change-over from one to the other. As can be seen in the photograph the cabinet containing the electronic equipment is on the right of the machine and a

plate for the mounting of templates is above the left rear end of the cross slide. The tracer head is mounted on a bracket on the vertical slide of the machine.

The profile turning equipment incorporates an automatic bias control, and any shape of template can be followed automatically without recourse to hand control. The only limitations of the shape which can be turned are those which are imposed by the cutting tool design. It is claimed that the accuracy both of form and repetition of size are of a very high order. Under ideal test conditions, repetition of size within 0·00075in on diameter is stated to have been obtained. This limit is not guaranteed, however, since the nature of the work material, the depth of cut and the likelihood of tool wear obviously have to be taken into account.

The electronic equipment has been designed for easy servicing and any one of four valve-carrying chassis can be removed and replaced by a spare in a few minutes. The diagram, Fig. 20, illustrates the fundamental, but simplified, operation of the electronic system. The direction of profiling and the feed is set, and after initiation of a profile cycle the stylus (shown concentric with the tracer head) moves in towards the template. When the stylus contacts the template the output signal from the head, via the analyser, calls for a further increase in generator output and, hence, movement of the appropriate motorised slide. When the stylus deflection reaches a predetermined figure a relay is energised and the output of the other generator causes the appropriate motorised slide to move the stylus, hence the tool, tangential to the profile to be followed.

At this point, under profiling conditions, the complex signal from the head is analysed and split into two electrical signals equivalent to the mechanical displacements in the two axes. (It may be noted that the complex signal from the head represents the amplitude and direction of deflection of the stylus from its initially deflected position.) These two signals are compared with a reference. The two resultant signals provide the control signals for adjusting the cross and vertical slides according to the change in output from the tracer head. As the tracer head is rigidly coupled to the vertical slide carrying the tool a faithful reproduction of the template profile is produced on the work.

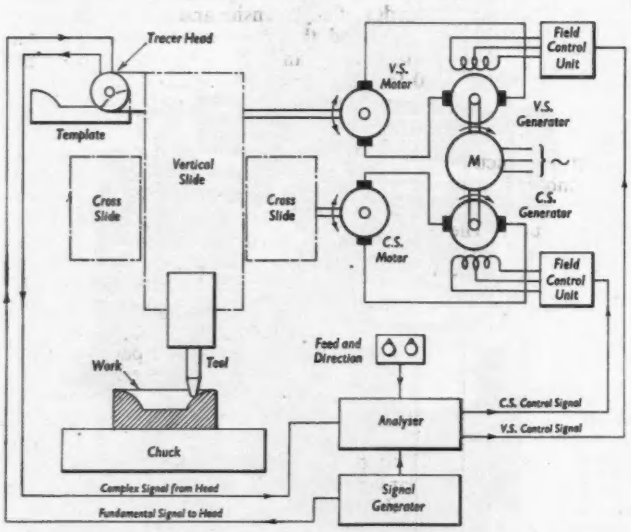



Fig. 20—Schematic diagram of electronic control equipment fitted on Webster and Bennett boring mill

**Drummond Brothers, Ltd.**

A multi-tool lathe of new design built by Drummond Brothers, Ltd., and to be seen upon the stand of Drummond-Asquith (Sales), Ltd., New Street, Birmingham, is the "Maxirapid" high-speed machine (Fig. 21). This machine is a development of the well-known "Maximatic" and is designed to meet the needs of the automotive and other high production industries. It has a centre height of 8½in and takes up to 24in between centres; the maximum swing over the saddle is 12½in and over the slides 10in. The lathe is of powerful, heavy construction, and has been designed to use tungsten carbide tools to their utmost capacity. The heavy metal removal rate of which the machine is capable has led to the use of an angular bed to permit chips to drop away to the base of the machine from which they are removed by an automatic chip conveyor. The angular design of the bed also facilitates the application of automatic handling of workpieces in and out of the machine, and the fitting of automatic gauging and chucking. Hydraulic units can also be mounted within the machine area for operating chucks, tailstocks and other loading devices.

The electrical control gear is mounted on the machine at eye level for easy access. A central pressure lubrication system automatically oils the headstock, feed box, saddle, and front and rear slides, and is so arranged that in the event of a failure in the lubricating supply the machine stops.

The headstock is of very rigid construction, the main spindle running on double precision taper roller bearings, and all shafts are mounted on ball or roller bearings. The drive is by constantly running 50 h.p. motor mounted on top of the bed and driving through "Texropes" and an electrically operated multi-plate clutch. Speed changes are obtained by pick-off gears, a high and low-speed range being obtainable by hand operation of a sliding gear; if required, an automatic two or three-speed change, operated by electric clutches, can be fitted. Three alternative spindle speed ranges are available—102 to 950 r.p.m., 145 to 1400 r.p.m., and 216 to 2000 r.p.m.

The saddle is operated by a leadscrew driven from feed box at the headstock end of the machine and it slides on "Nitralloy" hardened strips fixed to the bed. The cross slide bolted to the saddle is operated by a flat former plate cam on the "Maximatic" principle. Separate micrometer adjustment is provided for accurate tool setting. The cross slide can be fixed in any position on the saddle, and two cross slides can be fitted when necessary. The rear slide mounted on the top rear shear of the bed is adjustable to any position along the bed, and it is operated by a similar former cam plate to the front cross slide, separate adjustment being provided for the tools.

The feed control box fitted at the headstock end of the machine, controls all motions to the front saddle, cross-slide and rear slide. Feed traverse is effected by a chain drive from the main spindle through pick-off change gears and electromagnetic clutches on the lead screws. Rapid traverse and feed motions are controlled by limit switches operated by dogs on revolving cam drums, and the units for operating the front and rear slides are independent of each other.

The control of the machine is entirely by readily accessible push buttons on a panel at the front and all motion controls are interlocked for safe operation.

The "Maximajor" heavy duty automatic multi-tool lathe (Fig. 22) has been introduced to meet the need for heavy automatic multi-tool turning of components beyond the capacity of the "Maximatic" machines. It is made to swing up to 15½in over the bed, and is made in two lengths with centre distances of 78in and 102in. The machine operates on a fully automatic cycle under the control of a single lever, its front and rear slides being independently controlled and provision being made for easy setting.

The lathe can be supplied with a 60 h.p. a.c. motor or, alternatively, a 30 h.p. d.c. motor, giving infinitely variable speed through a 3 : 1 range. In both cases the motor drives the main headstock pulley by multi-strand vee belts. Starting and braking are controlled automatically from the dog drums in the feed box.

A heavily constructed headstock has a positive clutchless drive to the spindle, and pick-off gears and a sliding two-speed manual change provide a choice of eight spindle speeds. With both kinds of motor drive eight spindle speed ranges from 5 to 50 r.p.m. up to 30 to 300 r.p.m. are available.

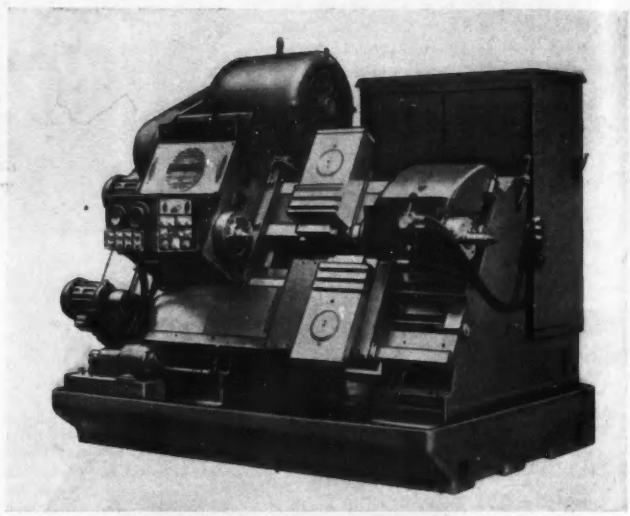


Fig. 21—"Maxirapid" high-speed heavy-duty multi-tool lathe—Drummond

The feed box is driven by chain from the spindle and contains two drums carrying dogs to operate the quick approach, feed and quick return to the front and rear lead screws independently, also the main motor starting and braking. Quick approach and return is effected by two independent 2 h.p. motors which over-run the normal feed motions. Feed changes to front and rear lead screws are effected independently by pick-off change gears and saddle feed rates from 0·003in to 0·031in per spindle revolution are available.

The saddle is carried on a large angle vee and will accommodate two cross slides. A flat carrier to which is attached the cross slide former plate is mounted within the top face of the saddle and is directly coupled to covered lead screws. An adjustable stop terminates the saddle cutting feed and starts the quick-return motion. The cross slide has inclined tool blockways and provision is made for initial micrometer adjustment. The feed is by roller pin acting against the former plate in the saddle top and when two slides are employed each has its own independent former plate. A dead stop on the infeed ensures accurate turning to diameter. The rear slide, which also has inclined tool blockways, can be located at any point along the bed, also two or more slides can be employed if required, each with its independent former plate.

The " Maxicut " electronically controlled copying lathe, illustrated in one of the Plates, has been developed in conjunction with Lancashire Dynamo and Electronic Products, Ltd. In it separate motor drives are employed for each motion, each motor being under the control of the electronic equipment which governs the direction and speed of rotation throughout the machining cycle. For this class of work a template or master component is mounted on the carrier, to be seen in front of the lathe bed, and the finger of the tracer head contacting the template produces a series of impulses governed by the template shape. These impulses start, stop, speed up, slow down, or reverse either the saddle motor or the cross slide motor, or a combination of both, to reproduce at the single point tool tip a movement corresponding to the shape of the template or master component. The constant-feed characteristic of the machine is of considerable advantage when steep angles and faces are encountered. One or more rear slides can be provided to facilitate the removal of bulk metal, thus easing the work of the front turning tool, and to form square grooves and other profiles, which cannot be produced by the turning tool.

The headstock of the machine is of heavy box-section construction and it provides any one of twelve spindle speeds when driven by a 20 h.p. or 40 h.p. single-speed motor. Alternatively, a 20 h.p., two-speed motor can be provided, giving a choice of twenty-four speeds. In each case any one of four speeds can be obtained by use of the manual gear change levers at the front of the headstock, while the complete range of speeds is obtained by the use of two pairs of pick-off change gears on the primary and intermediate shafts. The headstock carries no clutches, the motor being electrically braked and started or stopped by push button control. The feed box at the left-hand end of the machine contains two electric motors, one driving the front lead screw through worm and wheel, and cam drum with adjustable stops which make contact with micro-limit switches ; the other motor drives the rear lead screw through bevel gears and a second cam drum through worm gears. A second set of limit switches are located beneath this drum. Each motor is electronically controlled, that for the front lead screw being interconnected with the motor on the cross slide and driving through a magnetic clutch located immediately behind the feed box.

The cross slide carrying the tracer head is driven by the motor through spur reduction gears and a worm drive. This motor is controlled by the tracer head in conjunction with the saddle motor in the feed box. The worm wheel of this drive is mounted on a sleeve engaging with a double-ended screw which is fixed in the cross slide base. On rotation the sleeve carries the top slide and cutting tool towards or away from the work-piece. As accuracy of the piece produced must depend on the precise functioning of the cutting tool and the complete absence of any backlash in the sleeve, a simple adjustment is provided to eliminate backlash.

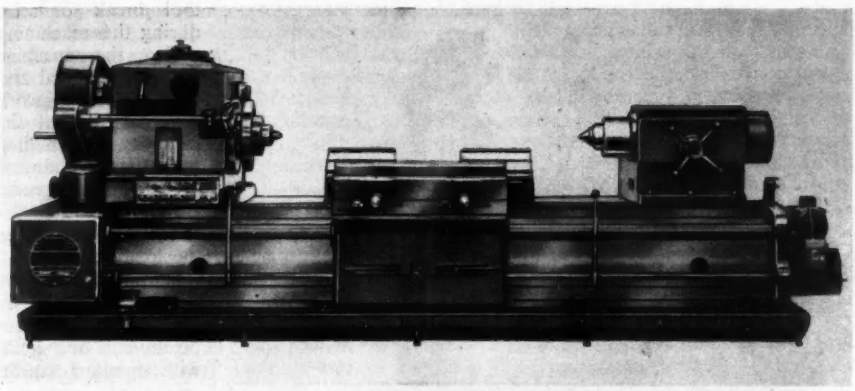


Fig. 22—" Maximajor " heavy-duty automatic, multi-tool lathe—Drummond

Means of manual operation of the slide for setting are provided by a capstan wheel, to which is mounted a second sleeve engaging with the fixed screw. By rotation of this wheel adjustment of the tool base can be effected and a collar graduated in one-thousandths of an inch is provided to facilitate fine adjustment.

In the automatic cycle of operations the point at which the infeed rapid traverse is cut out and the outward rapid traverse cut in is determined by two switches located under a cover on the cross slide drive unit. These switches are operated by adjustable dogs on a small drum mounted on a vertical shaft and driven through gears from a rack mounted on the side face of the front slide.

A press button control panel mounted on the cross slide drive is conveniently placed for the operator's use without having to move from his normal position. There are two dial controls, one of which governs the rate of feed to the front cutting tool (i.e. the rate of operation of the saddle and cross slide motors combined), while the other dial governs the rate of infeed of the rear facing tools. All feeds are infinitely variable between 0in and 10in per minute. Two push buttons are provided for rapid saddle traversing in each direction and a separate motor used for these movements is connected to the lead screw.

**Sir James Farmer Norton and Co., Ltd.**

The bar turning and straightening machines made by Sir James Farmer Norton and Co., Ltd., Salford, 3, Manchester, include centreless bar turning equipment arranged for fully automatic operation. The machine has a capacity for turning bars from ½in to 3in diameter and it is suitable for machining a wide range of alloys as well as the normal grades of high tensile and carbon steels. It is claimed that bars can be turned on the machine to an accuracy of plus or minus 0·001in in any 20ft length of bar with a maximum limit of ovality of plus or minus 0·00025in.

The machine has a stepless range of spindle speeds from 200 to 600 r.p.m., and eight feed rates from $^{1}/_{32}$in to ¼in per revolution of the spindle. Whilst they are being machined bars are gripped by hydraulic means in the travelling carriages. In the automatic sequence, the black bars are released one at a time from a stillage at the ingoing end of the machine and dropped into the gripping carriage. As the bar passes through the turning head its far end is gripped by the outgoing end carriage ; on completion of machining the bar is pulled clear of the head and released by the grip jaws. Arms then pick the bar up and transfer it on to finished bar racks, whilst the next bar feed and turning cycle restarts automatically.

Also shown is one of the firm's No. 4 size bar straightening and reeling machines of improved design. This machine can handle bars and tubes from ½in up to 4½in diameter, and can be supplied with automatic bar feed and discharge troughs to suit 15ft long bars. It is driven by a 100 h.p. motor through a two-speed gearbox and reduction gearing, giving throughput bar speeds of 25ft and 50ft per minute. The alloy steel rolls are driven through wobbler shafts and couplings and they are 18in diameter by 27in wide on the barrel. These rolls are mounted on double-row spherical roller bearings in cast steel housings, both rolls being provided with means of angular adjustment to suit different grades of material. The parallel roll also has lateral adjustment to suit the full range of bar sizes, its traversing housing being carried on four large tension bars across the heavy fabricated steel frame of the machine.

**B.S.A. Tools, Ltd.**

Some recent additions to the wide range of automatics made by B.S.A. Tools, Ltd., Kitts Green, Birmingham, are exhibited for the first time at Olympia, and they include two of the B.S.A. Acme-Gridley design, one being a 1⅜in " BRB " eight-spindle bar machine and the other a 6in " BR " six-spindle chucking machine.

It is pointed out that the 1⅜in eight-spindle machine has particular advantages over a four or a six-spindle automatic, in that it is capable of producing two pieces per cycle, or by double indexing two different pieces per cycle. It can also be tooled to include several operations, such as cross drilling, thread chasing, milling, to produce complete pieces in one cycle, thus eliminating need for

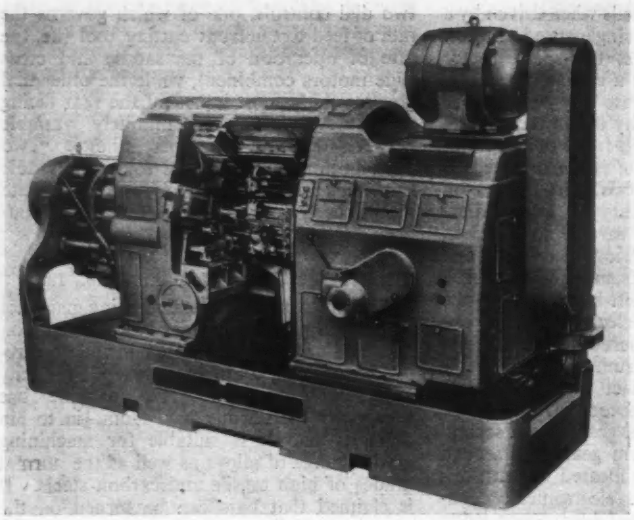


Fig. 23—Acme-Gridley 1⅝in eight-spindle automatic bar machine—B.S.A. Tools

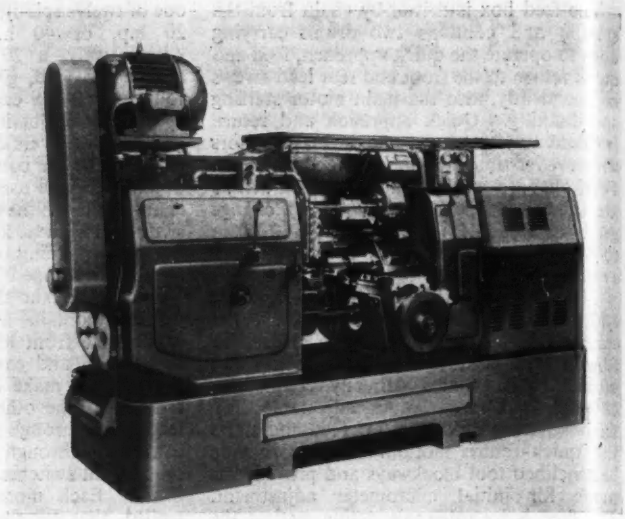


Fig. 24—6in six-spindle automatic chucking machine—B.S.A. Tools

second operations on certain classes of work. This machine, which is illustrated in Fig. 23, has a collet capacity for 1⅝in round, $1^{9}/_{64}$in square and $1^{13}/_{32}$in hexagon stock, the standard maximum stock feed length being 10in and turning length 8in.

The spindle carrier system is carried on large bearings incorporating means of adjustment to take up wear and it is indexed by a modified Geneva mechanism. This mechanism is designed to give rapid shockless indexing and the index arm roller engages hardened steel blocks on a gear continuously in mesh with the carrier ring gear. The main tool slide mounted directly on the spindle carrier is supported by the guide arm, which travels on a heavy guide plate below the carrier stem. On it there can be readily arranged a combination of tools, such as for turning and high-speed drilling in one position, and a positive stop gives close depth control when drilling or reamering and of length when turning.

Each of the cross tool slides is operated independently of the others and has an adjustable positive stop which engages a hardened stop on the periphery of the spindle carrier to give accurate control of forming sizes. The two lower cross slides are mounted on heavy bases supported low and well back into the frame without overhang. The two top cross slides are mounted on the top brace and each is independently controlled from a horizontal drum in the brace, driven through gears and a vertical shaft from the lower cross slide drum shaft. Intermediate slides centrally located to the third and sixth positions are each independently controlled and they permit many operations, such as finish forming, form turning, recessing, knurling, cut-off. These slides provide for widely diversified side tooling operations in keeping with the increased number and styles of end working tools made possible by eight-spindle design, depending upon the class of work.

The stock stop is operated direct from the main drum shaft in a long slide, and its movement is upwards and forwards at an angle to the stock feeding position, with a quick return to a rest position below a level of the side slides.

Feed change gears and spindle change gears at the motor end of the machine give a range of spindle speeds from 163 to 1475 r.p.m., and a wide selection of feeds are available. In the gearbox an efficient braking mechanism, combined with large disc and roller clutches, minimise non-productive time and safeguard the machine and tools during changes from highly accelerated idle movements to productive movements. To save time on setting-up, change-over and tool adjustment, as well as to make hand cranking unnecessary, a power feed reversing mechanism is included as standard equipment.

The stock feeding mechanism is rigidly supported at both ends. One end is fastened in the headstock frame, and the other end, including the front of the stock reel, is held in the arch support rising from the rear end of the pan. The front disc of the stock reel turns in a guide mounted directly on the end of the pan, and the reel is independently power indexed through a separate shaft and gear. This eliminates torsional strain and any tendency to whipping action and excessive wear in the spindle carrier.

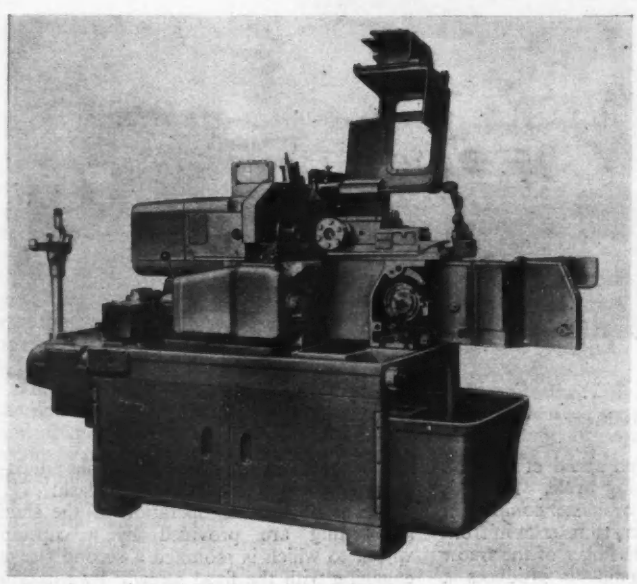


Fig. 25—¾in capacity, single-spindle "68L" automatic screw machine—B.S.A. Tools

The 6in six-spindle chucking automatic (Fig. 24) is hydraulically operated with fully automatic spindle clutch and brake operation and semi-automatic chucking through a manual control lever. It has a maximum turning length of 7in. Drive is transmitted through vee belts from a 25 h.p. motor over the headstock, and the spindle speed range is from 108 to 1154 r.p.m. The main tool slide mounted on the spindle has means of variable fine end adjustment in relation to the chucks and the drum carrying its actuating cams is accessible from both sides of the machine.

Four cross slides are rigidly mounted in a bridge of the main frame and this form of mounting enables heavy forming cuts to be taken effectively at high speeds. A hydraulic distributor located on the spindle end of the machine releases a chuck in any spindle position. Should a tool break or seize during the machining cycle, the machine may be stopped and the tools or work removed without the necessity of pulling back the tool slide and indexing the spindle carrier until the desired spindle reaches the loading station.

The machine is arranged to thread in the third or fourth positions, or both, with standard attachments, and means of second and fifth position threading can also be provided. The same slide and operating mechanism, in any of these positions, can be used for accelerated reaming or turning operations. As the slides in each position are operated by a separate set of cams, a selective feed is available in either position. If required, independent turret slides for third and fourth positions may be fitted to the top rail.

The B.S.A. "68L" single-spindle automatic (Fig. 25), which incorporates a number of new points, is the British version, of equivalent capacity, of the B.S.A. "18L" metric machine, and is of ¾in capacity. A one-piece casting forms the base of this machine and in it are housed the spindle drive gearbox, coolant tank and swarf pan. The open front body rigidly supports the headstock, cross slides and turret slide to

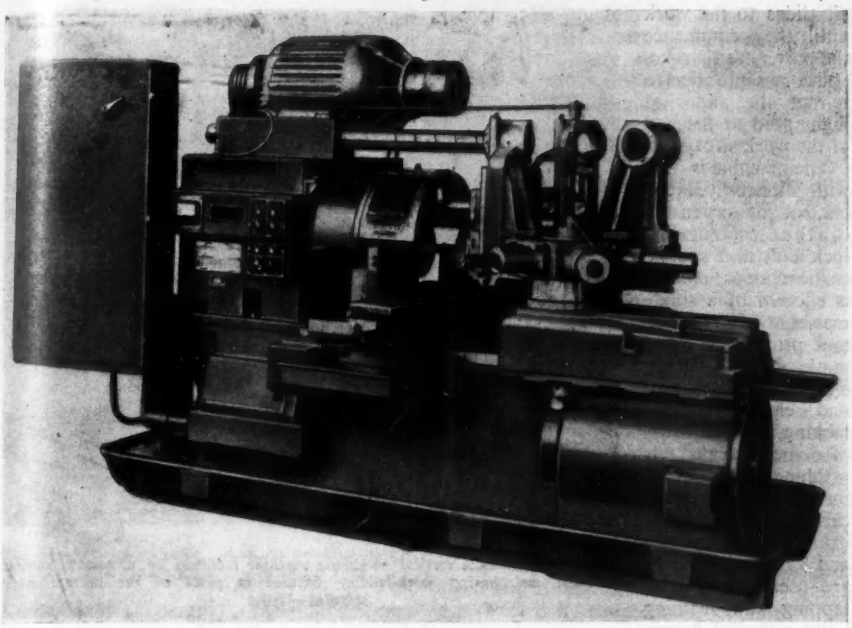


Fig. 26—Potter and Johnson "6DRE-40" automatic turret lathe—B.S.A. Tools

ensure vibration-free cutting and accuracy. The standard machine is arranged to give two speeds—forward and reverse, or both speeds in the same direction, and, if required, a four-speed gearbox can be supplied. The gearbox with speed change gears and chain adjusters is readily accessible through the large double doors at the front of the base.

The totally enclosed backshaft and clutch tripping mechanism are readily accessible and all clutch locating plungers operate directly on the final driven members—turret crankshaft, change speed cam and bar feed cam. This arrangement is designed to obviate clutches sticking due to incorrect setting of plungers and ensure that the connecting-rod in the turret is accurately aligned after each indexing movement to give consistent length control of components.

The camshaft gearbox, for obtaining the cycle times, is of the constant centre design and a device is incorporated for disengaging the backshaft clutch should the machine be overloaded. Worm drives to the two camshafts have independent adjustments for mesh and end play, and the gearing is so designed that backshaft clutches engage at the same instant in each cycle to ensure accurate control of depth when tapping blind holes and timing of feed out when clearances are small.

A straight withdrawal and advance mechanism which is built into the turret of this machine enables the turret to be rapidly retracted and advanced to the same position without indexing, the turret head remaining locked during the operation. By this means deep holes can be drilled with a single drill and only a minimum of time is lost while the drill is cleared of swarf. The straight withdrawal mechanism may be operated as often as desired and at any point in the machine cycle.

The front cross slide is operated direct from its cam by a single lever, whilst the rear cross-slide is actuated by a cam lever, push rod and reverse motion lever at the rear of the machine.

The single top slide has micrometer adjustment parallel to the work axis, giving accurate length control and a fine screw adjustment facilitates tool centring for either left-hand or right-hand cutting. Double top slides, which may be fitted in place of the single slide form a single unit, complete with a camshaft driven by a vertical shaft from the main worm shaft of the machine. The front slide carries a $^{5}/_{32}$in thick cut-off blade for parting-off, whilst the rear slide, using a $\frac{9}{16}$in square section tool, acts as an additional forming slide. Each slide has independent longitudinal adjustment and changeover from single to double top slide can be accomplished in a very short time as both are located by the same fixing studs.

The work spindle has a speed range of 53 to 4480 r.p.m. and is mounted in a box section headstock on adjustable taper roller bearings at the front and cylindrical rollers at the rear. The clutches are designed to give a predetermined torque value, which remains constant at all temperatures. In an improved design of collet mechanism swinging levers replace the use of collet tube thrust pads to decrease friction and provide for a greater proportion of the effort applied by the toggle levers being transmitted to the collet.

A hydraulic copy turning lathe made by the firm is based upon the B.S.A. multi-tool lathe and is suitable for both batch and large-scale production with semi-skilled labour. It swings up to 6in over the tool slides and takes work up to 27in long between centres.

The company is now making the Potter and Johnston "6 DRE 40" automatic turret lathe under licence. This machine (Fig. 26) has a new design of headstock with a 40 h.p. motor, which provides ample power for fast metal removing, using tungsten carbide tooling. Automatic spindle speed changes are effected through electro-pneumatic multi-disc clutches, and as the drive for the turret and cross slide feed is taken from the spindle, feed is automatically maintained in inches per revolution with spindle speed changes.

Cross slide motion relative to turret motion is obtained via a timing box through which retiming of relationship is readily made. The normal set-up provides two cross slide movements in conjunction with the turret slide for rough and finish facing, grooving, &c., and a third movement whilst the turret dwells in its forward position for operating a slide tool.

A recent addition to the machine tools made by B.S.A. is a vertical broaching machine, which has a 7 tons pulling capacity and a maximum stroke of 36in at cutting speeds of 4ft, 6ft and 9ft per minute. As can be seen in Fig. 27, the machine consists essentially of a combined table and gearbox, which is supported on four pillars on a cast iron bedplate.

The gearbox mounted at the right-hand side of the work table takes its drive from a flange-mounted motor at the rear, and vertical lead screws are driven through a train of gears housed in the table assembly.

The dual lead screws are 2½in diameter with a ½in pitch Acme form thread, and the pulling load is taken by heavy-duty ball thrust races. The tractor bridge is designed to guard the lead screws on the three sides nearest to the broach and give full protection from chips. The pulling jaws automatically grip the broach and they are opened automatically by an adjustable stop when the tractor bridge returns to the top position, or they can be operated by means of a pedal. The stroke of the tractor bridge can be adjusted to suit broaches with a cutting length of up to 36in. A retriever attachment can be supplied so that when the tractor bridge has returned to the reload position and the pulling jaws released the broach is lifted clear of the table by the air-operated hoist, while the operator loads the next workpiece. The broach is then lowered until the pull end is in position in the tractor bridge and the machine is started in the normal way. The lifting head of the retriever unit is so designed that it automatically locks

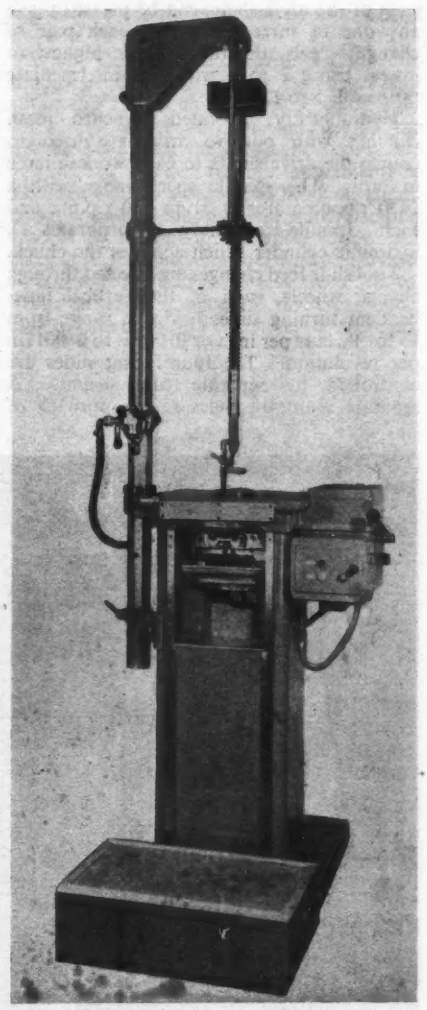


Fig. 27—36in stroke vertical broaching machine with retriever unit—B.S.A. Tools

on to the broach while it is lifted, but releases as soon as the broach is seated in the tractor bridge.

**Thomas Ryder and Son, Ltd.**

Two new designs which have been introduced to the range of vertical automatics made by Thomas Ryder and Son, Ltd., Turner Bridge Works, Bolton, are the "8T Verticalauto" and the "10/8 Verticalauto," which are shown in operation on the firm's stand, together with one of the "18 Rydermatic" standard vertical single-spindle chucking lathes.

The new "10/8" machine is a heavy-duty, eight-spindle chucking machine equipped with 14½in diameter hydraulically-operated chucks, eight turning slides and four facing slides. It can also be supplied as a six-spindle machine with 17in diameter chucks. The machine (Fig. 28) is designed to swing up to 15½in diameter, the normal stroke length of the turning slides being 12in and of the facing slides 10in. It is driven by a 60 h.p. motor and power is transmitted through a worm and wheel and change wheels, which are located in the same compartment as the feed change wheels, to a large central ring gear. Cluster gears on each of the drive shafts can be preset to give any one of three speeds for each pair of change wheels, the ratio of the highest to lowest being 2 to 1 with one intermediate ratio of 1·5 to 1.

Hydraulically operated synchro-mesh clutches with positive drive are used to couple the drive shafts to each work spindle in turn. The spindle speed range with a 1450 r.p.m. motor is 31 to 610 r.p.m., and each spindle assembly incorporates a hydraulic cylinder which actuates the chuck.

Tool slide feed changes are effected through change wheels, each of the vertical independent turning slides having a range from 15 to 592 cuts per inch or 0·067in to 0·0017in per revolution. The four facing slides are controlled by separate cam drums. A separate motor provides rapid approach of all slides to the work until they commence the power feed stroke, and comes into effect to retract the slides at high speed at the end of the work stroke.

The machine is built with electro-hydraulic control of spindle clutches, indexing, lock bolt and spindle carrier clamps: control is effected by a single master timing drum, and provides an automatic cycle with full hydraulic, mechanical and electrical interlocking. For purposes of demonstration this machine is tooled for machining rear hub castings of malleable iron. At stations 6, 7 and 8 multi-tool heads are used for drilling, tapping and reaming holes in the hub flange.

Fig. 28—Eight-spindle heavy-duty vertical automatic with electro-hydraulic control and a fully automatic cycle set by a master timing drum—Ryder

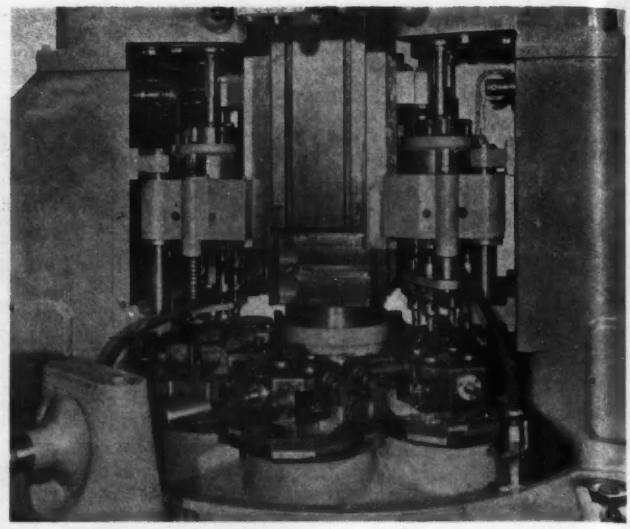


Fig. 29—Six-spindle vertical automatic machine modified as a rotary transfer machine and having work-holding fixtures in place of the normal work spindles—Ryder

The "8T Verticalauto" exhibited is the firm's standard six-spindle automatic modified as a rotary transfer machine, and it is arranged for drilling and boring front-wheel spindle stampings of 55-ton steel. As can be seen in Fig. 29 and one of our Plates, it has holding fixtures fastened to the indexing table, in place of the six revolving work spindles normally fitted. Each of the six fixtures can grip four workpieces which are drilled and bored by toolheads carrying four revolving spindles. The heads are mounted on the five turning slides. A further modification is the replacement of the standard facing slide units by side arms bridging the top gearbox to the base. These arms carry the motors supplying power to the toolheads.

The standard "18 Rydermatic" on the stand is tooled for machining steel front hub forgings which are gripped in 18in pneumatic chucks and supported by pneumatic tailstocks. The profile of the hub is turned by means of a vertical former-controlled turning slide and a horizontal facing slide carries the facing and forming tools.

**Central Tool and Equipment Company, Ltd.**

The group of small production milling machines shown by the Central Tool and Equipment Company, Ltd., Hemel Hempstead, Herts, includes the firm's recently developed "3R" two-dimensional machine, which is designed to work automatically to a programme consisting of any sequence and any number of movements of the table and cutter head. On it the cycle is set by the positioning of buttons in slots and no cams are used for even the most complicated set-ups. The whole of the control slide used can readily be removed from the machine and stored for re-use, so that a number of slides can be kept to adapt the machine for a range of work.

The basic "Centec 3" machine is illustrated in Fig. 30, and, as can be seen, the head is carried on a slide on the column and is offset from the centre-line of the main body. The table reciprocates on the rigid bed and the vertical and cross movements in machining are effected by the head. For vertical movement the head slides up and down the column over a distance of 8in and for the cross movement the quill containing the spindle moves over a length of 2½in in the head. The table has an 8in by 30in working surface and is hydraulically operated over its 14in stroke, at speeds from ¾in to 36in per minute. The automatic table cycle can be arranged to give fast approach speeds at 300in per minute, slow cutting feed and fast return.

The machine is driven by a 4 h.p. motor and is electronically controlled to give a stepless range of spindle speeds from 50 to

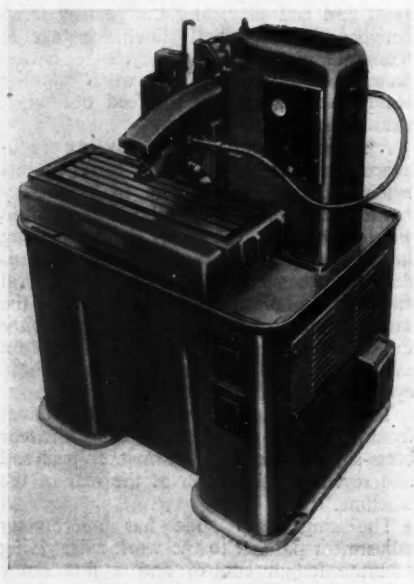


Fig. 30—Automatic cycle production milling machine with electronically controlled spindle speed and hydraulically operated table—Central Tool

1400 or 200 to 2800 r.p.m. Spindle speeds are controlled from a single dial operating a rheostat, and a two-speed gearbox. A dynamic breaking circuit stops the spindle when the stop button is pressed or an automatic stop is used.

When the machine is equipped for

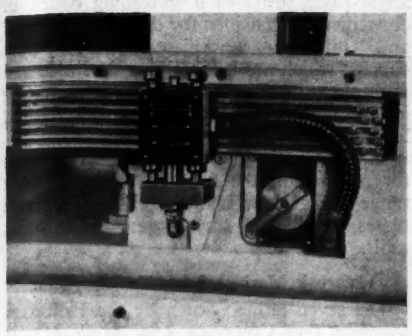


Fig. 31—Control slide for automatic two-dimensional production milling machine—Central Tool

hydraulically operated two-dimensional milling, the control slide shown in Fig. 31 is fitted to control the automatic rise and fall of the cutter spindle head and other operations. With it the spindle can be fed down to six different levels, which can be automatically predetermined and which are controlled by positive stops. The vertical movement of the spindle is controlled in the same way as the horizontal movement. A solenoid pilot valve provides a fast vertical approach of the spindle, followed by a steplessly variable preset feed. As the switch-over from fast to feed at any preset position is controlled by buttons, no cams are necessary. The rapid traverse is over 300in per minute and the vertical feed rate is from ½in to 36in per minute, allowing cutting during the vertical movement.

This machine can also be supplied equipped with tracer controlled hydraulic copying equipment. The equipment made for use with these machines includes an indexing table and a pneumatic vice.

### Cincinnati Milling Machines, Ltd.

The group of milling machines on the stand of Cincinnati Milling Machines, Ltd., Woodlands Farm Road, Tyburn, Birmingham, includes five general-purpose and four production millers incorporating the latest developments. The firm's "2 MI" machines are represented by a vertical and the universal miller illustrated in Fig. 32. By the use of up to eight control dogs in slots in the front of the tables available for these machines they can be readily arranged for automatic machining cycles. The universal machine illustrated has a 52½in by 10in table, and the traverses available are 28in longitudinally, 10in transversely and 18in vertically.

The standard spindle speed range is from 25 to 1500 r.p.m., and there are sixteen feeds from ½in to 30in per minute, both of which are selected by simple crank-operated dials. A rectangular overarm is actuated on its slide on the column by a small capstan handle and incorporates a built-in vibration damper.

One of the firm's "1-18" automatic milling machines and an "0-8" rise and fall miller are shown producing typical small components at high speeds, and a 16in "Hydrotel" (Fig. 33) is engaged in an interesting die-sinking operation. This "Hydrotel" machine is made in three models—the basic machine for general-purpose work; fitted with automatic depth control; and arranged for 360 deg. profiling.

In this machine the fixed height bed is integral with the rear base, the table being carried on wide gibbed ways on the bed and the cross slide assembly on ways on top of the rear base. A vertical spindle head is mounted on the front face of the cross slide. Each of the three sliding units—table, cross slide and vertical head—is hydraulically actuated and controlled. The automatic tracing equipment operates in parallel with the hydraulic slide system. Handwheel controls with micrometer dials used for the three main slides actuate servo-mechanisms in the hydraulic system and no appreciable physical effort is required to operate the units of the machine. Power feeds to both the table and the cross slide are actuated by individual motor-driven valve control mechanisms through directional control levers at the operating position of the machine. Each of these feed control levers has five positions—feed in each direction, rapid traverse in each direction, and a neutral or stop position. The feed rates are steplessly variable between 1in and 25in per minute and there is a rapid traverse rate of 120in per minute. The table has a working surface of 16in by 53in and a travel of 30in, whilst the cross slide has a traverse of 16in. There are sixteen spindle speeds from 25 to 1500 r.p.m., available through the setting of a single crank on the front of the spindle head, which has a vertical travel of 10in.

When the machine is arranged for die-sinking as shown in Fig. 33, it is fitted with automatic tracer control gear, which synchronises the vertical movements of the spindle head with the table and cross slide movements. The tracer mechanism is mounted on the side of the head on slides, giving means of longitudinal, transverse and vertical adjustment to the tracer finger. An automatic feed attachment, which provides a controlled cycle of cross feed movements at each reversal of the cross slide, can be fitted to the machine, if required.

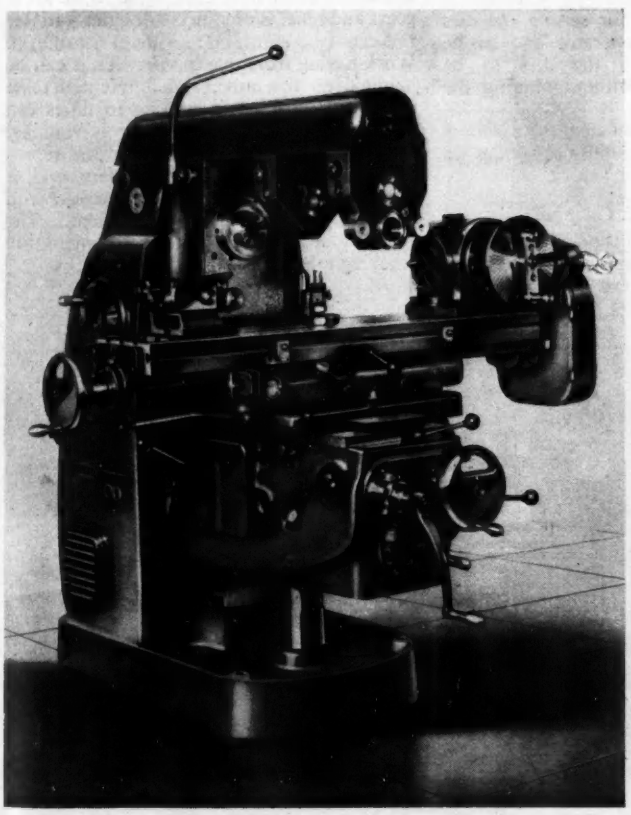


Fig. 32—"2MI" universal milling machine with sixteen spindle speeds and sixteen table feed rates through selector dials—Cincinnati

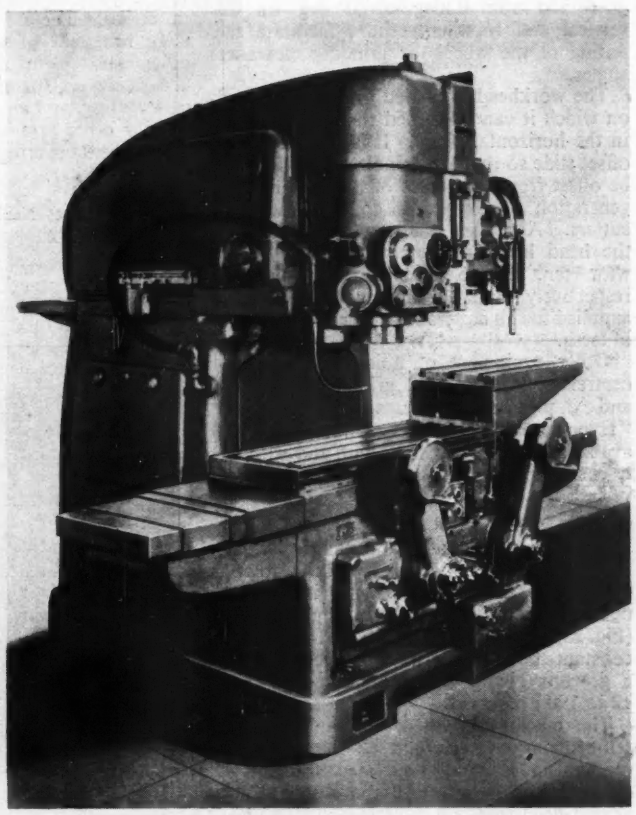


Fig. 33—16in "Hydrotel" hydraulically-operated vertical milling machine fitted with automatic depth control tracing mechanism—Cincinnati

Amongst the grinding machines exhibited is one of the "Microset" grinders for cutter and tool sharpening or manufacture from the solid, if required, without the use of special attachments. This machine (Fig. 34) swings up to 12in over the saddle and up to 6in long. It has a built-in lead mechanism for generating straight or tapered right or left-hand, infinitely variable spirals having leads as low as $1\frac{13}{16}$in. This is a sine-bar mechanism, which rotates the workhead spindle when the main slide is shifted, through a rack, pinion and bevel gear drive. The wheel spindle head is carried on slides giving longitudinal, transverse and vertical means of adjustment through handwheels

Fig. 34—"Microset" cutter grinder with built-in spiral lead mechanism—Cincinnati

with micrometer dials, and accurate positioning is made possible by the use of stop dogs with micrometer screw adjustment. Scales graduated from 0 deg. to 25 deg. on the vertical and transverse slides facilitate the setting of the wheel for grinding clearance angles.

The workhead is carried on a swivel base, on which it can be turned through 235 deg. in the horizontal plane. It is carried on an offset slide so that the spindle centre-line can be offset from the centre of the base for the generation of convex or concave radii on cutters. A ratchet indexing mechanism on the head has three separate ratchet plates with ten, twelve and fourteen notches respectively, and additional plates can be supplied to suit cutters with different numbers of teeth.

Other equipment on this stand includes centreless grinders, tool grinders and plain and duplex arrangements of the firm's "Hypowermatic" milling machines, which are available in forty-two sizes, with and without tracer control.

### Joshua Heap and Co., Ltd.

The group of automatic tangential die head screwing machines of Joshua Heap and Co., Ltd., Ashton-under-Lyne, includes a new 2in capacity bolt screwing machine (Fig. 35). It is driven by a 5 h.p., 1430 r.p.m., constant-speed motor through vee belts and a gearbox giving nine spindle speeds from 12 to 190 r.p.m.

The machine is fitted with an open-jaw self-centring box vice and all the operating mechanism is totally enclosed to prevent damage from swarf. All the shafts in the geared headstock are mounted on ball races and the main spindle is carred on preloaded angular contact and roller bearings. A

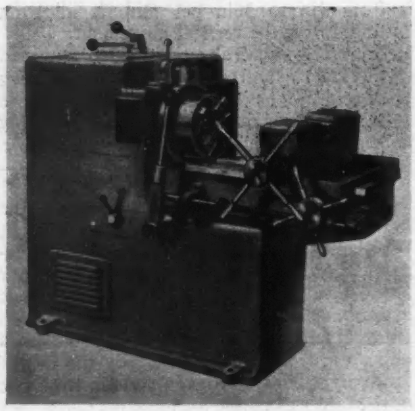


Fig. 35—2in capacity automatic tangential die screwing machine with nine spindle speeds and 15in carriage travel—Heap

roughing and finishing mechanism enables threads of over $1\frac{1}{2}$in to be cut in two passes, although the maker states that this is only really necessary in the case of tough alloy steel bolts under 2in diameter.

The hand releasing motion for the diehead is operated by a lever on the side of the machine, and the dies are also opened automatically when any predetermined length up to 15in has been screwed. The dies close automatically on the return of the work carriage. These dies, of the maker's own design, are so built that the diehead locks within itself so that no strain is thrown on the clutch or operating levers when cutting. The cutting strain is taken on the hardened and ground steel inserts on the cam ring which forms a solid ring round the die holders. These inserts have full width contact with the hardened steel contact block of the die holders and the cutting strain cannot force the holders out of position so that a parallel thread must of necessity be produced. The incline for setting the dies is in full view of the operator and a fine adjustment plate allows the dies to be accurately set for size without altering the cam setting.

Four other screwing machines are shown by this firm covering threading capacities up to 6in diameter.

### James Neill and Co., Ltd.

Permanent magnet chucks are now being made by James Neill and Co. (Sheffield), Ltd., to meet practically all general requirements in the toolroom or on production lines. The well-known range of rectangular models up to 24in long for use on surface grinders has been extended by the introduction of a 7in by 4in surface chuck which bridges the gap between the 10in by 5in and the firm's "minor" chucks and which, used in conjunction with the "Eclipse" swivel angle plate, provides a swivelling chuck of convenient dimensions for dealing with small and intricate workpieces. Heavy-duty chucks, which are being shown in single and multiple units, have flush ends for mounting in continuous formation into any desired length.

In addition to its numerous magnetic aids for production the firm is also showing a range of hacksaw blades and frames, angle plates, vee blocks, surface gauges and other tools.

### Holbrook Machine Tool Company, Ltd.

The seven lathes shown by the Holbrook Machine Tool Company, Ltd., 44-48, Martin Street, London, E.15, include a new toolroom lathe known as the model "U," No. 17, and having a swing of 24in over the bed. This machine (Fig. 36) is driven by a $7\frac{1}{2}$ h.p. induction regulated motor, and its stepless range of 3 to 725 spindle speeds is arranged in four geared groups. The spindle, carried in Timken roller bearings, has a $7\frac{1}{2}$in diameter flange and is fitted with an American standard D 1·6in camlock nose for the easy interchange of chucks. Spindle speed is regulated by a knurled knob set below a tachometer on the front of the headstock.

A dial change gearbox provides sixty direct changes of English pitches from $1\frac{1}{4}$ to 76 threads per inch, and change gears are provided to obtain metric, module and coarse pitches. A long bed cover is fitted to the carriage, which has a wide base to carry a cross slide with built-in relieving motion mechanism. This relieving drive is transmitted through a splined shaft with spiral gears and relief is obtained through a variable rise cam with a normal maximum rise of $\frac{5}{16}$in. Work having from one to thirty flutes can be handled on the lathe, and differential relief of the tool position in relation to flutes can be adjusted whilst the machine is running. Profiling equipment is fitted for the reproduction of spiral fluted form cutters, and, if required, the machine can be supplied with constant cutting speed equipment. The "17U" machine is shown in operation relieving a hob.

(*To be continued*)

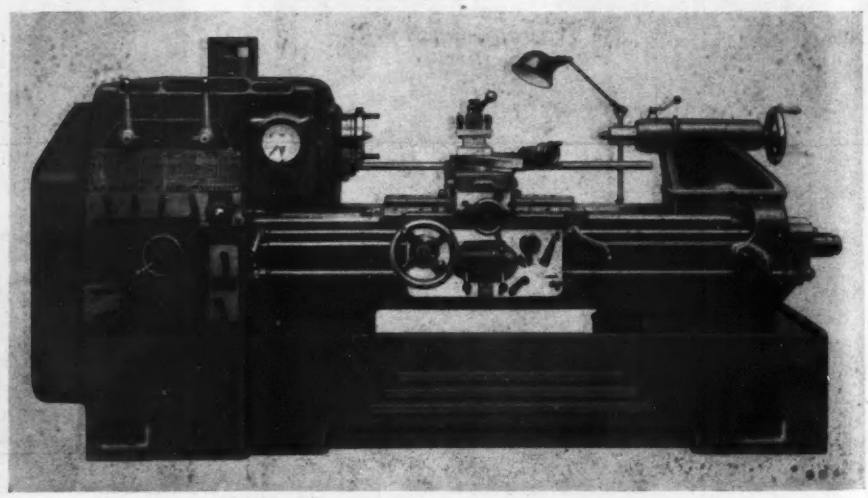
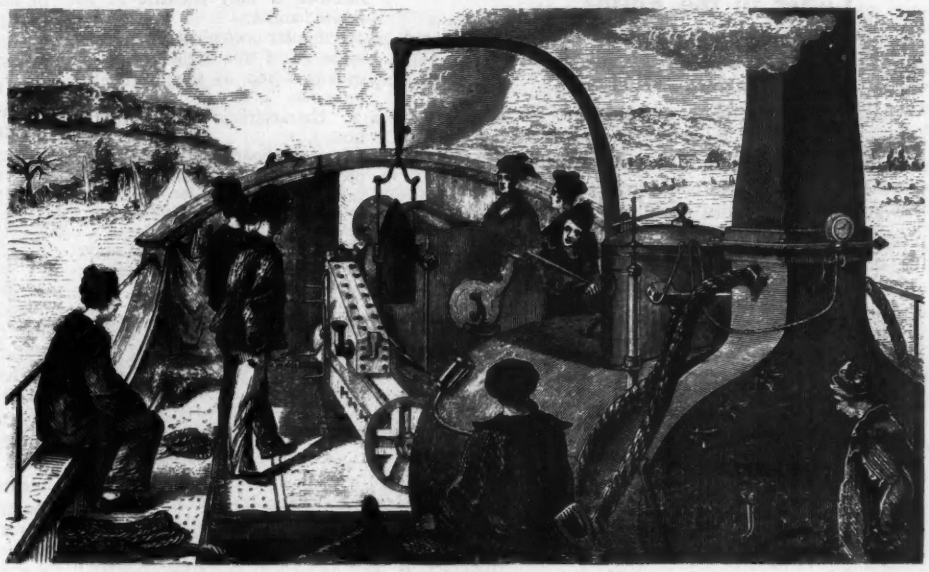
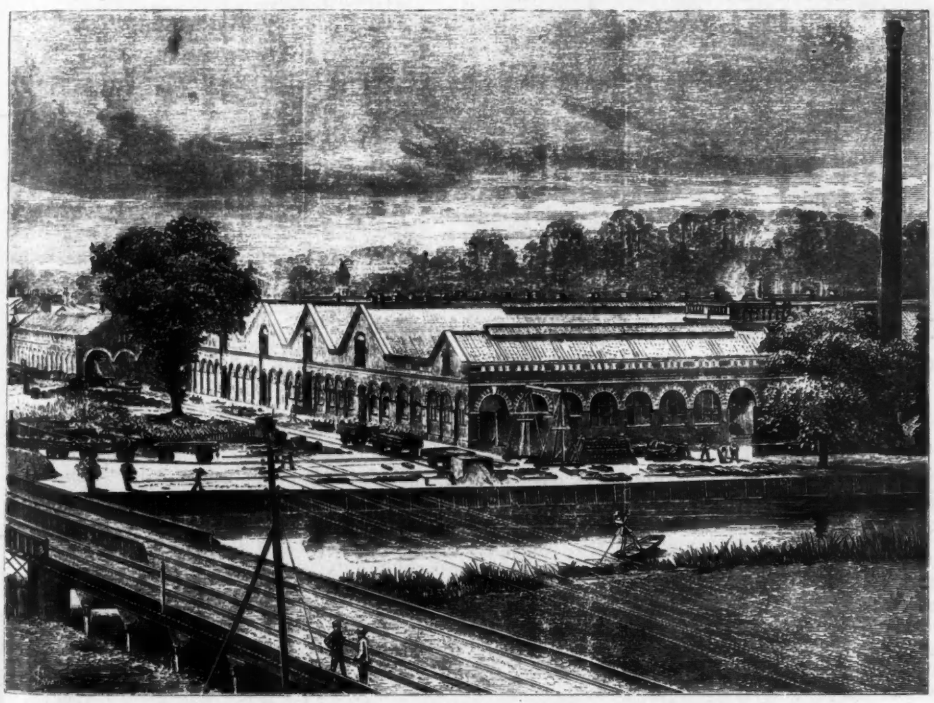


Fig. 36—Tool-room lathe to swing 24in over the bed, fitted with relieving motion and having a stepless range of spindle speeds from 3 to 725 r.p.m.—Holbrook

# ENGRAVINGS OF 1870

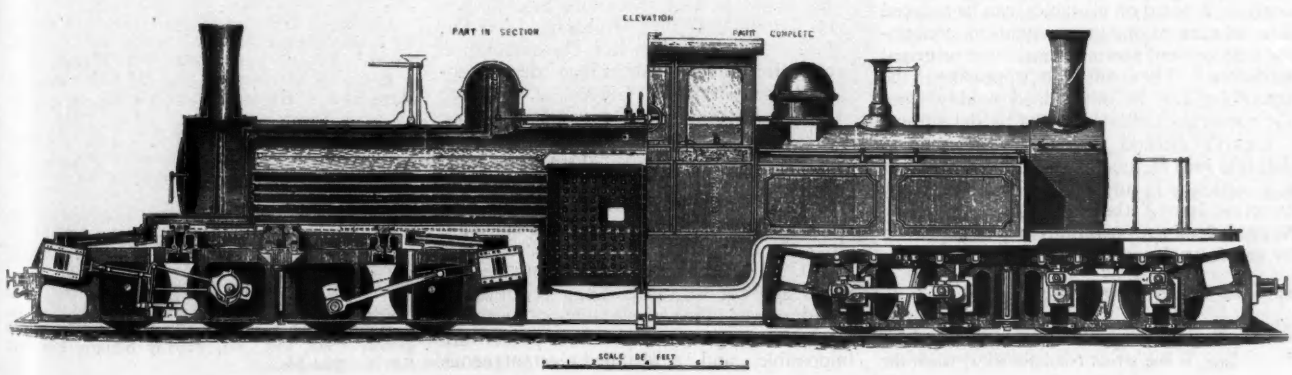
The right-hand engraving, reproduced from our issue of November 18, 1870, shows the Farcy gunboat on the River Seine, during the siege of Paris. We explained that the drawing from which the illustration was prepared was dispatched to us "by balloon post from our special correspondent." Our article goes on to say: "this mischievous little craft is an object of the greatest interest with us, and a puzzle to the enemy. It carries a 15-ton gun on a boat that looks ridiculously small; the problem which Lieutenant Farcy set himself to solve was the carrying of the largest possible gun on the smallest possible craft, and this he has succeeded in accomplishing. Lieutenant Farcy has managed to place a 15-ton gun, with a carriage weighing 7 tons, 32in above the centre of gravity, with only $4\frac{5}{10}$ tons of engine, boiler, screw and shaft as a counterpoise. In spite of its great breadth the Farcy gunboat has a speed of six knots, although its engine is only in the proportion of 10 horse power for 50 tons of displacement."





Our issue of September 16, 1870, contains a full account of the activities of James and Frederick Howard, of Bedford. Their business started round about 1837, the manufacture of ploughs being their principal occupation. Our article includes the engraving of the Britannia Ironworks, Bedford, which is reproduced here. We described the works as being "amongst the most renowned of our agricultural implement manufactories." The original buildings were completed in 1857, and the main purpose of our description in 1870 was to record certain alterations and additions, in particular the new foundry "shown nearest to the foreground in our engraving."

The engraving below illustrates a quadruple-bogie locomotive, which was designed by Mr. G. Percy Spooner, of Portmadoc. This engraving appeared originally in our issue of July 8, 1870, wherein it is stated: "this engine is intended for conducting heavy traffic on railways, at a small cost, and in many cases will be the means of avoiding the necessity of two lines of way, the capabilities of the engine being such as to embrace all the power required for heavy goods or other trains, avoiding the use of auxiliary engines; it is constructed on the Fairlie principle."

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# LETTERS AND LITERATURE

## Letter to the Editor

*We do not hold ourselves responsible for the opinions of our correspondents)*

### FOREIGN MADE

SIR,—What a refreshing experience we enjoyed on the TV recently to see Sir F. Handley Page upholding the merits of British know-how in the aircraft industry. Perhaps it would be a good idea if we had a similar programme relative to the machine tool industry, in which, I suppose, one finds a most appalling debunking of any machine tool that is made in Great Britain and conversely that anything that comes out of Germany or the United States is superlative. In fact, to the average man employed in machine shops or tool rooms the machine tool that has a name like a well-known cinema organ or sausage must be endowed with wonderful engineering features that is far better than anything Britain can make. It does appear, however, that quite a number of firms in this country who, in adopting a policy of sending certain personnel to Germany or the United States, have managed to achieve the desired effect of inculcating into the mind of the young persons the idea that anything that comes out of those countries is wonderful and anything that Britain produces in a similar sphere is, of course, no good at all. Furthermore, we find that anything that is British made and may be better than her foreign competitors must be kept in the dark ; in fact, it does appear to be almost a crime to uphold a British product over the German product. The phraseology being, of course, that it is "German made, old man," which immediately conjures up visions of equipment possessing supernatural powers.

A. L. MOUNTER

Brighton, June 8th.

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## Literature

*Sistemi Elastici Piani* (*Metodo Dell 'Incognita Principale*). By ATTILIO LINARI. Pellerano-Del Gaudio, Naples. Vol. I (text). Price L2000 ; Vol. II (tables). Price L1000.

THERE are already many books which try to simplify the analysis of engineering structures by the extensive use of tables and diagrams. This book by Linari should not, however, be considered as a mere addition of another set of tables to the above group. The author calls his approach "method of the principal unknown" and shows that in many cases, even for highly redundant structures, the analysis, if based on his tables, can be reduced to a solution of one linear equation, containing only one unknown, termed "the principal unknown." The coefficients, appearing in the equations, can be determined readily from the numerous tables compiled by the author.

Linari's method is basically a modified deformation method. He proves that for any section $x$ in any general member $jk$ any stress resultant $Z_x$ (bending moment, shearing force, deflection or rotation) may be expressed by the following general equation :

$$Z_{x(jk)} = \zeta_{x(jk)} + c_1 \cdot \varepsilon_A + \Sigma c_j \cdot \eta_j + \Sigma c'_j \cdot \gamma_j,$$

where

$\zeta_{x(jk)}$ is the stress resultant at $x$, when the member is fully encastré at its nodes $j$ and $k$.

$\varepsilon_A$ is an angular coefficient of the first node $A$ of the structure (it is usually taken as the "principal unknown").

$\eta_j$ is a "characteristic" factor of the node $j$.

$\gamma_j$ is an angular coefficient of the node $j$ produced by the yielding of the support $k$.

and

$c_1$, $c_j$ and $c'_j$ are constants, whose numerical values can be taken from the tables, prepared by the author.

He also groups the usual kinds of plane structures into several different classes (continuous beams of constant or variable second moment of area, rigid frames with or without sway, Vierendeel trusses, roof trusses, closed rings and arches), and derives special formulæ for the characteristic factors of each of these groups and calculates the numerical values of the constants $C$. For most of the considered structures the proposed method becomes surprisingly simple and rapid, leading to only one unknown. All continuous beams and some types of Vierendeel trusses belong to this group. For them the method is really powerful.

Other kinds of structures yield only a very limited number of linear equations. It should be emphasised that the method gives an exact and not an approximate answer. It becomes very useful when applied to the determination of influence lines. Also it allows one to locate rapidly the sections of the maximum bending moments under any system of loading.

Vol. I, containing 242 pages, discusses the theory and the derivation of the formulæ. It explains the use of the tables and contains a vast number of worked-out examples.

Vol. II, 141 pages, contains only the tables, which are an essential part of this method.

The book is written generally in a clear and simple manner : the approach is interesting, the treatment is logical, starting with simple structures and working gradually up to more complicated systems. The only irritating thing, which may be noticed by some readers, is a surprisingly high number of "extra explanations" and footnotes—in fact, some pages in Vol. I contain up to five notes of this kind. Generally, the book in its present form is well produced. It might prove a useful addition to the libraries of some engineers fully conversant with theory of structures and with a working knowledge of Italian.

*Etude Experimentale des Ecoulements Gazeux.* By M. MERLE. Publications Scientifiques et Techniques du Ministère de l'Air, No. 308. Service de Documentation et d'Information Technique de l'Aéronautique, Magasin C.T.O., 2, Avenue de la Porte-d'Issy, Paris (15e). Price 1100 francs.

THE study of airflow around an obstacle is rendered difficult by the fact that any measuring device introduced—a Pitot tube, for instance, or a hot-wire anemometer—alters the flow pattern to a greater or lesser extent. To introduce a great number of such instruments into the stream is out of the question and thus simultaneous measurements at a great number of points are impossible, and a detailed instantaneous picture of the flow cannot be obtained. On the other hand, there are three so-called "optical" methods available which do not interfere with the flow pattern and permit the taking of instantaneous photographs from which certain quantities may then be derived. The methods in question are the interference method, the Schlieren method and the shadow method. All three depend on changes in the index of refraction with pressure, being sensitive, respectively, to pressure, pressure gradient and the derivative of the pressure gradient. In addition there is an "acoustic" method which consists in superposing standing ultrasonic waves on the flow. These are made visible by the optical procedures mentioned and form a pattern of lines which, as it is displaced by the air stream, permits the velocity field to be calculated. Mademoiselle Merle, in the present treatise, describes the experimental work carried out by her at Marseilles. By means of the methods mentioned it proved possible to measure Mach waves, temperatures, and the flow patterns around obstacles at low speeds, and to study the shock waves produced inside a tube. A second part of the book deals with the details of the experimental work, the difficulties which arose and the results obtained.

*Mains Practice.* By T. H. CARR, M.I.C.E., M.I.E.E., M.I.Mech.E. George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Price 35s.

MANY books, some of them classics, have been written about cables, overhead lines, transformers and switchgear, and other specialised aspects of the transmission and distribution of electricity. There are not so many books, however, covering the whole subject of mains practice. In the book under review the emphasis is on practice rather than theory. The first few chapters are concerned with general considerations, methods of transmission and distribution, and system design, and the rest of the book, constituting the bulk of the text, is concerned with selection of plant, substations, methods of cabling, cable joints and terminations, and overhead lines. There is a brief but useful appendix on statutory procedure in Great Britain. In all, a good deal is compressed into 352 pages and some topics, inevitably, are squeezed out ; but we hope that space may be found in a future edition for better treatment of the subject of electrical protection.

### Books Received

*The Diecasting Process.* By H. K. Barton. Odhams Press, Ltd., 96, Long Acre, London, W.C.2. Price 25s.

*Elementary Technical Electricity.* Second edition. by L. T. Agger. Longmans, Green and Co., Ltd., 6 and 7, Clifford Street, London, W.1. Price 9s.

*Design of Reinforced Concrete.* By Boris W. Boguslavsky. The Macmillan Company, New York, 10, South Audley Street, London, W.1. Price 42s.

*The Science and Practice of Welding.* Fourth Edition. By A. C. Davies. Cambridge University Press, Bentley House, 200, Euston Road, London, N.W.1. Price 18s.

*Pocket Book for Mechanical Engineers.* By David Allan Low. Edited by Bevis Brunel Low. Longmans, Green and Co., Ltd., 6-7, Clifford Street, London, W.1. Price 21s.

*Progress in Nuclear Energy, Series I, Physics and Mathematics.* Volume I. Edited by R. A. Charpie, J. Horowitz, D. J. Hughes, and D. J. Littler. Pergamon Press, Ltd., 4-5, Fitzroy Square, London, S.W.1. Price 84s.

# Opencast Coal Working at Acorn Bank Site

*The Acorn Bank Site for opencast coal working near Bedlington, Northumberland, is expected to yield 5,000,000 tons of coal in the next seven years from the three seams which cross the area. This calls for the delivery of 16,500 tons of coal per week to the screening plant, and to do this 40-ton bottom trailers have been built and a private road has been constructed.*

LAST year the contract to mine the Acorn Bank site was awarded to Costain Mining, Ltd. It calls for the recovery of more than 5,000,000 tons of coal within a period of seven years. The site, which has an area of some 440 acres, is close to Bedlington, in Northumberland, and contains three seams of coal named High Main, Top Grey and Bottom Grey. These vary in depth and spacing over the site, the lowest seam ranging in depth from 230ft in the north-east corner to 100ft in the west. There is 40ft between High Main and Top Grey at the western boundary, diminishing to 6in in the east, whereas the interval between the Grey seams increases from 15ft in the north to 120ft at the south-east corner of the site. The thickness of High Main averages 3ft 3in including a thin shale band; Top Grey consists of two leaves, each about 2ft 7in thick, with a 2½in band; and Bottom Grey has four leaves, of which the top and bottom are 3ft 1in and 2ft 10in thick respectively, and the middle two are each 8in thick. Over the coal seams are normal strata of shales and sandstones, and over the area is a boulder clay drift up to 30ft in thickness.

Early restoration of the ground to its original agricultural purposes formed a clause in the contract and posed an operational problem, since working by the permanent ramp system was impracticable. The solution adopted was to use high-speed electric derrick cranes, on the high wall, to hoist the shovel-loaded skips for discharge into trucks on the top of the cut. Working the site involves forming a box cut some 3200ft in length by 100ft wide at the bottom seam along the eastern boundary and then proceeding to move westwards by making a succession of parallel cuts about 80ft wide, at the same time filling in the previous cut. The photograph reproduced below gives a general view of the site and work proceeding on the box cut. The months up to date have been occupied in opening up the job by removing the top soil and underlying subsoil to tip and the over-burden. About 8,000,000 cubic yards of the latter have been moved and approximately 170,000 tons of coal recovered in making the box cut. With the preliminary stages completed it is expected that shortly the system will be working at maximum capacity, which is the excavation of 1,000,000 cubic yards per month. It is estimated that the contract will involve the removal of about 95,000,000 cubic yards. Part of the over-burden already removed is being hauled about a mile to the worked-out Ewart Hill site to restore the area and improve drainage, and the remainder will be used to fill in the final cut.

For the removal of top soil and subsoil five "Tournapulls" and a Euclid scraper are in use, while for handling drift and rock to a line 140ft above and parallel to the bottom coal three Ruston-Bucyrus electric shovels of 5 cubic yards capacity are in operation. Two Bucyrus-Erie draglines, one having a 180ft boom and the other a 215ft boom, are removing the remaining over-burden, which is being prepared by three Joy-Sullivan rotary air-blast drills. In the initial working 22-ton and 15-ton capacity rear dump trucks, numbering sixty, have been engaged, loading being by means of a skid-mounted hopper, except for the larger trucks, which are being loaded direct from a 22-yard Hendrix bucket. To ensure clean digging from the seams hand labour assisted by graders and bulldozers, is being employed, and experiments are being carried out with a tractor-mounted power brush with a view to effecting a saving in labour. Electric shovels of 1½ cubic yards capacity dig the coal and load into 10-ton derrick skips, the electrically operated derricks having 152ft jibs.

View of new coal haul road, showing two of the three bridges

Site working and the initial box-cut at Acorn Bank

By crushing and blending it is planned to produce a uniform mixture having a maximum ash content of 10 per cent, from coal having an ash content ranging from 3·5 per cent in High Main to 25 per cent in Bottom Grey. The coal is not to be washed, but is being screened at a plant erected at Bebside convenient for rail transport and about 1½ miles distant from the site. Here three 12-ton capacity hoppers feed three 36in belts, each of which has a capacity of 150 tons per hour. Discharge is over 2in square-mesh vibrating screens, and the large coal passes to picking belts, where low-grade material is removed and later returned to the cut. High-quality coal is boom loaded into railway wagons, while poor-quality coal is diverted to Jeffrey-Diamond crushers, where it is crushed to under 2in size and conveyed by belt for blending with similar size material from the high-quality screens.

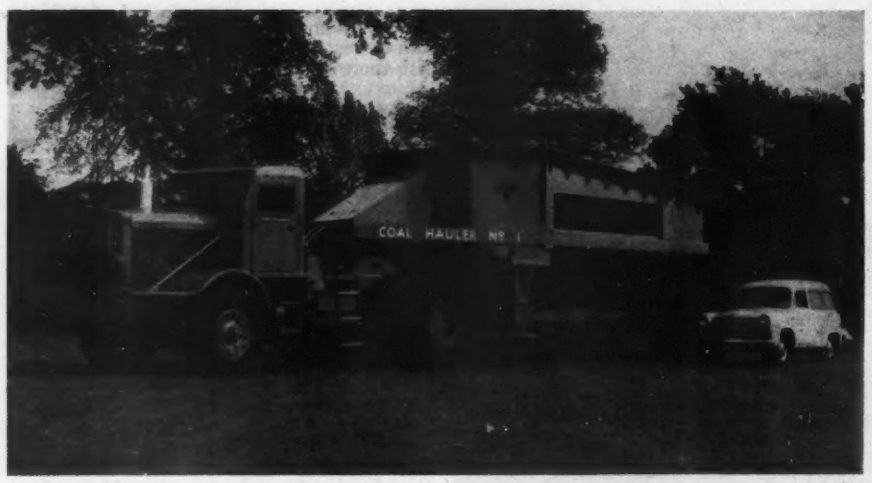
Coal from the initial box cut was transported to the screens by 10-ton rear dump trucks along the public highway. The road in question is not ideal and this, coupled with the statutory regulation limiting the payload to about 14 tons for a three-axle vehicle, raised questions of economics and performance if 16,500 tons of coal per week

were to be delivered at the screens. Due consideration of the problem resulted in the company deciding to build, as a private venture and entirely outside the contract, a 30ft wide carriageway from the site to Bebside. Apart from obtaining the necessary approval from interested local authorities and Government departments, the road has called for the building of three flyover bridges and a considerable amount of excavation. Part of the private road and two of the bridges can be seen in our first illustration. For rapidity of construction triple/single extra widened Bailey bridging was chosen, and two 120ft long units supported on 4ft diameter concrete columns cross over main roads, while a third, 190ft long, crosses the River Blyth on timber trestles. Mass concrete has been used for the foundations and sawn greenheart planking for the decking, while guard frames are fitted as a precaution against falling coal. The whole scheme has been completed in the short time of thirteen weeks.

Cutting and grading the road involved the excavation of 50,000 cubic yards of drift and clay and the use of 100,000 cubic yards of rock fill. Gradients and superelevation at bends are calculated to allow a speed of 30 m.p.h. for the coal haulers. In combination with the availability of a private road, which removed the limitation on loading, the company determined upon the mass movement of coal and evolved a transport system which called for eight bottom-dump semi-trailers and four prime movers. These have been designed and built by the Eagle Engineering Company, Ltd., Warwick, and the trailers have a capacity of 60 cubic yards, sufficient for a load of 40 tons of coal. The first of the trailers and prime movers to be delivered to the site are illustrated below. The all-welded body is mainly of ½in on ⅜in thick steel plates, stiffened by channel and angle sections, and the single unsprung rear axle is shod with four Dunlop 18in by 25in "Power Grip" tyres, which have an air pressure of 60 lb per square inch, and is capable of carrying a load of 30 tons.

At the forward corners of the body are two hydraulic jack legs operated from a pump, mounted on the tractor, to which they are connected by two pipelines fitted with self-seal couplings. A compressor, also tractor-mounted, supplies air at 60 lb per square inch through two pipelines, fitted with palm couplings, to the braking system. To economise in men and machines an automatic fifth wheel is fitted and the trailer is equipped with a sprag pattern land anchor to sustain the load when coupling-up. The Euclid prime mover, which has five high and five low gears, is powered by a 270 h.p. Rolls-Royce supercharged diesel engine and has been adapted for tractor operations by the Eagle Engineering Company, Ltd. The bottom unloading doors are of double-flap design with a 3ft 4in gap which are opened by a quick release lever and closed by manually-operated gearing. This arrangement will permit the trailer to be emptied in approximately seventeen seconds.

To accommodate the increased size of loads, the hoppers at the screening plant have been built up to 40 tons capacity and over them are two runways, each consisting of four prestressed concrete beams, between 18ft to 22ft in length, to take the tracks of the tractor and trailer. The round trip from site to screens and back is timed to take thirty minutes and when the full complement of eight trailers and four tractors are operating, 40 tons of coal will be delivered to the screens at intervals of seven-and-a-half minutes.

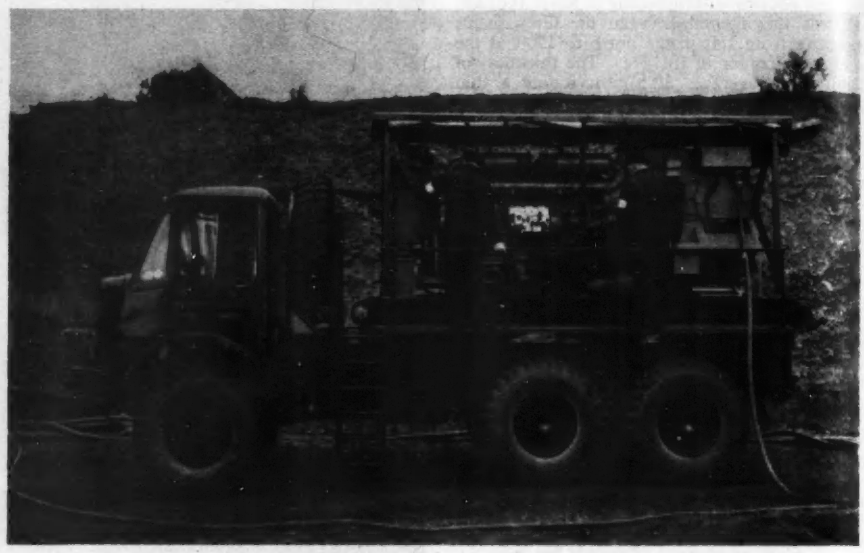



**40-ton capacity bottom dump semi-trailer and tractor**

# Mobile Emergency Mine Winding Equipment

WE recently attended a demonstration of the mobile emergency winder which is stationed at the National Coal Board's colliery at Lynmouth, Northumberland. The equipment forms a self-contained winding gear which can be used at any shaft equipped with headgear, or can fulfil the statutory requirement for a standby winding engine.

The power unit of the mobile winder is an A.E.C. "0860" six-wheeler with an 11·3-litre six-cylinder diesel giving 150 h.p. at 1800 r.p.m. and driving through five-speed main and two-speed auxiliary gearboxes. The tractor incorporates a winch powered from the main transmission, and the winch cable can be led directly from the rear of the vehicle or out of guides behind the front bumper bar. This bar also has a simple towing pin. The normal towing hook is of the closed pattern, and is kept locked upright when the trailer is attached. A separate hand control for the air brake system applies the trailer brakes alone. Carried on the tractor is an English Electric generator set with a six-cylinder engine, which has a twelve-hour rating of 195 h.p. at 1250 r.p.m., driving a shunt-wound generator giving 78kW at that speed. A level



**Diesel-electric generating set for emergency mine winding equipment**

compound-wound generator to supply the fields of both main generator and motor is mounted above the generator and driven by vee belts. The generator engine, like the traction engine, is started by a 24V battery-energised motor, but does not have any alternative means of starting. Auxiliaries include a warning light to show that this motor is running, a hand pump to flood the overhead valve gear with lubricant before starting, and a battery charging generator. A radiator is provided to cool about 2000 gallons per hour of water and 1700 gallons per hour of lubricating oil. Fuel for five hours' running is stored in a skid on which the engine and main generator are based, and there is a hand pump to fill this tank. Magnetic float switches give half an hour's warning and then shut down the set when low fuel level is reached. The gross weight of the vehicle is about 17 tons.

Coupled to the tractor by a rigid tow bar is a six-wheeled Crane trailer. The suspension of this is essentially similar to that of the prime mover, the rear wheels being loaded by two half-elliptic springs pivoted to the chassis at their centres, but separate torque reaction links are omitted, the axles being clamped to the spring ends. Although all axles have air brakes, relay operated from a reservoir on the tractor, the half-elliptics on the front axle are mounted in slides at both ends. Inside the road wheels are plain metal drums to run on standard gauge railway track, those of the centre axle being flangeless in order to follow curved track. For rail travelling purposes the turntable can be locked. This turntable can be steered by a simple screw jack linkage and its limited travel when disengaged requires the lock of the turntable to be restricted by stops.

Trailer-mounted motor driven winding equipment

running on 320V d.c., through double reduction gearing, and can carry 3000ft of 2in wire rope on a 4ft diameter, 3ft wide drum. A Ward-Leonard control system gives speeds of up to 8ft per second, and hydraulic brakes are provided. Automatic stops are geared to the winder and located accessibly for setting, and a depth indicator needle moves along a scale in front of the operator, on which the stopping points can rapidly be marked with chalk. Bell and telephone communication equipment is provided. The roof over the rear of the vehicle is a roller shutter opening upward, and the operator has a clear view of the winder and pithead through a large window in the rear wall of the cab. The total weight of the trailer is about 17½ tons.

This provision is made because the winder, having no cable spreader, must be aligned accurately with the pithead gear, and a set of sights are mounted in the vehicle to show where the sheave should be. When working on rails, the vehicle cannot be turned since the jacks, which take its weight during operations are unequally located beneath it, two at the rear on a transverse beam and the third on a folding tripod behind the turntable. To assist in manœuvring the trailer alone, a hand cranked winch is mounted at the extreme rear. The chassis kicks down into a rigid box form above the rear axle beams and here is mounted a winder supplied by Robey and Co., Ltd. This winder is driven by a 95 h.p., 1000 r.p.m. motor,

The third vehicle of the emergency unit demonstrated was a Leyland six-wheeler, again with two pivoted rear springs, and powered by the six-cylinder overhead camshaft "Terrier" petrol engine. This vehicle is fitted with five pumps driven by the main engine.

The demonstration took place at the disused Newburgh Colliery, a light lift being lowered into an empty shaft. The whole of the equipment appears simple and strong. It has been found that the tractor, by using its winch, can transport the equipment across very rough ground. The hoist is capable of a 2-ton load at the bottom of a 3000ft shaft.

# 150 Years of Chain Making

ON Tuesday, June 12th, we visited Newbridge Works, Pontypridd, in order to attend the 150th anniversary celebrations of Brown, Lenox and Co., Ltd. This firm's business in the manufacture of anchor chains can be said to have started in 1806. The business was founded by Lieutenant Samuel Brown, R.N., who, it is claimed, invented the first wrought iron chain cables ever to be used for practical purposes. To demonstrate the advantages of his invention, Brown fitted out a ship named the "Penelope" with her entire rigging of chain and with chains for her cables; he made a voyage to the West Indies in this ship in 1808. The experience gained during the voyage encouraged Brown to suggest to the Navy Board that it should investigate the advantages of iron chain cable, and to that end a committee of naval officers was appointed. The favourable report presented by the committee led to the Government of the day ordering four "vessels of war" to be equipped with Brown's wrought iron chain cables. It should be added here that while he was developing his wrought iron chain cable, Samuel Brown also introduced the stay pin, or stud, to prevent the links from collapsing.

Brown's first inventions were worked out in a house in Dove Court, Lombard Street, London, his early manufacturing activities being carried on in Narrow Street, Ratcliffe, and at premises near to Waterloo Bridge. As his work proceeded, however, Brown realised that additional capital was desirable for the progress of the business, and in consequence he formed a partnership with Samuel Lenox. The partnership subsequently became known as Samuel Brown, Lenox and Co., and early in 1812 a works was built at Millwall. There Brown invented and constructed his first cable testing machine. By 1816 the firm's business had expanded to such an extent that it was necessary to seek additional factory accommodation; the site at Pontypridd, South Wales, was acquired and the second Brown, Lenox works built. A few years later the partnership was extended by the inclusion of J. T. Walker and George W. Lenox, and Captain Brown, as he had by then become, began to take considerable interest in the building of suspension bridges and similar structures. Probably, his best-known work in this direction was the erection of the old chain pier at Brighton, which was completed in 1825. It is of interest to recall that a sum of around £27,000 was raised by public subscription to finance the project, and it is recorded that towards that amount over £17,000 was obtained by Samuel Brown's own efforts.

In 1835, Captain Brown was knighted, and by then his firm was manufacturing anchors and iron buoys, the production of which was concentrated at the Millwall works. The chain making business, however, lost none of its importance, and for more than 100 years from 1808 the firm was regularly awarded the annual contract for the Navy's chain cable requirements. There were other notable contracts which were fulfilled by Brown, Lenox and Co., among them being the iron cables for the "Great Eastern," designed by I. K. Brunel. Last week, at the Pontypridd celebrations, there was displayed a photograph of I. K. Brunel against a background of the cables made for the "Great Eastern." Sir Samuel Brown died in 1852.

At the beginning of the present century the firm extended its interests still further by starting up the production of railway wagon springs and various items of colliery equipment. It was by then operating its own rolling mills at Pontypridd. A steel foundry was built in 1922, and in 1928 the production of cast steel cables was started. On the occasion of our recent visit we were able to see how in the works at Pontypridd the old craft of smithing is continued side by side with modern methods of steel founding and general engineering work. An exhibition of the firm's products, both ancient and modern, conveyed a good impression of the marine and other equipment to the design and manufacture of which Brown, Lenox and Co., Ltd., continues to devote its attention. The display included, for example, an automatic coil lifting tong for steel works, samples of iron and steel chains and anchors, and also a model of a roller fender which the company has recently designed in collaboration with the British Tanker Company, Ltd. Briefly, this device consists of a set of three large steel rollers suspended vertically in a frame. These rollers are held in position by vertically placed hydraulic pistons arranged behind them. As a ship encounters the fenders, the hydraulic mechanism absorbs the force of the ship's forward movement, and the fenders revolve, allowing the ship to move forward into its correct position for mooring at a quayside or dock wall.

The 150th anniversary celebrations were arranged to coincide with the official opening, by Sir George Briggs, of some new laboratories which the firm has built at the works at Pontypridd. The laboratory block contains a well-arranged chemical section, a physical testing department, a heat-treatment and pyrometry department, and an inspection section. The accompanying illustration shows the balance room. There were also displayed at the works plans of an "Asea-Svets" automatic chain and

Balance room in the new laboratories, showing an electron microscope of magnification ×1000

cable making plant, which the company has decided to install at an estimated cost of £120,000. It is stated that with this plant—which will need only four or five operatives—3¼in to 4in mild steel chain will be produced at a rate of about 2 tons an hour. The plant is expected to be ready for production next year.

Following the opening of the laboratories, the guests were entertained to luncheon in a marquee erected in Pontypridd Park, which was formerly part of a farm owned by the Lenox family. In the marquee, historic records and correspondence were displayed, as well as a length of wrought iron chain supplied to the Admiralty in 1808. The chairman of the company, Colonel P. H. Jones, presided at the luncheon and responded to a toast which was proposed by Sir George Briggs. A toast to the guests was proposed by Mr. Hugh Lenox, and acknowledged by the Archbishop of Wales and Mr. E. Julian Pode.

## Ceramic Tools

We have received from Firth Brown Tools, Ltd., Sheffield, some interesting notes on the development work which the firm has carried out on ceramic tools. These tools, as is now generally known, are particularly hard and dense forms of alumina to which additions of other substances have been made.

In initial cutting tests by Firth Brown Tools, Ltd., cast iron and mild steel were machined and the results with ceramic tools compared with the hardest grades of hard metal. The results obtained were as follows :—

Cast iron :

| | | |
|---|---|---|
| Material cut | Close-grained cast iron | 220 Brinell |
| Conditions | Speed | 1000ft/min. |
| | Feed | 0·010in |
| | Cut | 1/8in |

| | Duration of cut | Flank wear |
|---|---|---|
| Hard metal | 45 seconds | 0·85–2·02mm |
| Ceramic | 38 minutes* | 0·34mm |

* Tool would have cut longer.

Mild steel :

| | | |
|---|---|---|
| Material cut | 0·2 per cent C | 150 Brinell |
| Conditions | Speed | 1500ft/min. |
| | Feed | 0·006in |
| | Cut | 1/8in |

| | Duration of cut | Flank wear |
|---|---|---|
| Hard metal | 7 minutes† | 0·51–1·64mm |
| Ceramic | 45 minutes | 0·34–1·17mm |

† Tool cutting very badly after one minute.

The speeds used in these tests were, of course, much higher than are generally available in industry to-day but were necessary to give measurable tool wear in reasonable time and to conserve test material.

The ceramic tool material is made up in the form of rectangular pieces which are mechanically held in a suitable tool holder, as shown in the photograph we reproduce. It has been found advantageous to provide the tool holder with a hard metal face on which to support the ceramic tip. Tools used so far have had an approach angle of 30 deg. and an included plan angle of 100 deg. The top rake used has varied from −3 deg. to −8 deg., with little variation in performance occurring over this range. In most cutting tests which have been carried out so far, chip control has been achieved by varying the feed/depth of cut ratio rather than by the use of a chip breaker. Early attempts to use a chip breaker indicated that unless this was critically adjusted, it could have a very adverse effect on tool life.

Ceramic tool cutting at 1500ft per minute. Depth of cut 1/16in, feed 0.006in

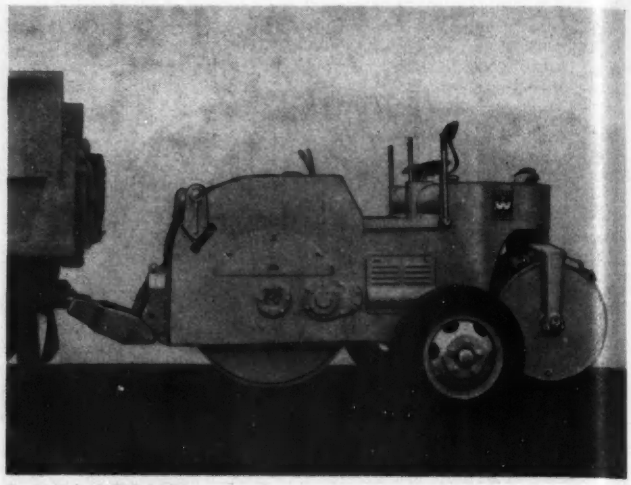
In addition to tests under the cutting conditions described above, which are at present used as standard tests to evaluate the quality of laboratory produced batches of material, some initial tests have been carried out on other steels, such as heat-treated EN18 and EN23, to try and evaluate the field of usefulness of the new tool material. Tests have also been carried out on the finish machining of austenitic stainless steel, but so far results on this material with ceramic tools have been rather disappointing, due to what appears to be a built-up edge. This probably presents a problem on the evaluation of correct tool shape which will be further investigated.

The firm has found that under suitable conditions, far higher speeds with much longer tool life can be obtained with the ceramic tools than can be obtained with hard metal. While, however, the ceramic material shows to best advantage at high speeds, it will, nevertheless, give much longer tool life than carbides at intermediate speeds of, say, 300–800ft per minute. The finish obtained with the ceramic tools is extremely good and much superior even to that obtained with the hardest grade of hard metal.

The brittleness of ceramic tools imposes limitations on its use. Thus, only finish machining operations under good conditions can be carried out, and engaging and disengaging the tool from the work calls for some skill on the part of the operator, if spalling is to be avoided. On the other hand, the tools are not difficult to grind provided a diamond wheel as used for hard metal tools is used. It is considered that there is no evidence to suggest that a ceramic tool will be cheaper than one of hard metal, the production processes being so involved that the prices may be higher even though the raw material costs themselves are lower. The firm states that at present its work is purely of a development nature and supplies of material cannot be made available.

## Transportable Road Roller

The 3–5-ton tandem roller built by the Huber-Warco Company, of Marion, Ohio, U.S.A., is now available with a towing attachment. The towing hitch at the front of the roller can be fitted with a power hydraulic jack, and will take the weight of that end of the roller while the detachable stub axles are fitted in housings below the sides of the plant. The height of the towing attachment can then be adjusted through 8in to give a level towing attitude. As can be seen in the illustration, axle carriers are provided high up at the front of the roller to carry the wheel assemblies when working. The wheels run on taper roller bearings and have 7·50×20 tyres.



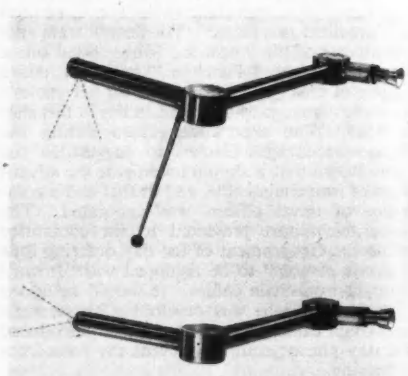
This 3/5-ton tandem roller can be mounted on pneumatic tyres for towing

The roller has a 41 h.p. engine driving through a torque converter to a transmission, giving two speeds forward and backward. A governor is fitted to the torque converter output, and it is claimed that road speeds are maintained precisely despite variations in rolling resistance. Further to facilitate a fine finish, the guide roller is mounted on taper roller bearings, which are readily adjustable to eliminate scuffing. Steering is hydraulic, and the pump delivery can be varied to give any desired feel to the operator. The roll scrapers are also easily adjusted.

The plant is distributed by J. Blackwood Hodge & C.., Ltd., 25, Berkeley Square, London, W.1.

## Industrial Periscopes

A variety of periscopes, intended rather for installation in plant than as portable instruments, is now available in this country from P. W. Allen and Co., 253, Liverpool Road, London, N.1. The tubing of these Bodson periscopes is normally 1·2in in diameter, and the total length of the light path can be as high as 25ft. The configuration of the instrument is decided by the individual application. The field of view is normally 45 deg., but magnifications of up to 8× can be provided with angles down to 6 deg. As can be seen in the illustration, a scanning prism can be arranged to turn in the objective tube or, if required, to move to and fro. The objective can be made air or watertight, while for use in fissile reactors the periscope is made from stainless steel with cerium-stabilised radiation-resistant glass lenses. The optical qualities allow photographs to be taken by means of an attachment to the eyepiece.



Industrial periscopes

# Industrial and Labour Notes

### Electricity Prices

The Central Electricity Authority has stated this week that it has requested the area electricity boards not to increase their tariffs despite the latest substantial increase in the price of coal. The electricity supply industry, recognising the present critical stage of the national economy and having regard to recent Government statements about "price steadiness," will carry the added burden although this will seriously reduce the industry's working margin, and involve a number of the area boards in individual deficits. A year ago, the C.E.A. recalls, the electricity supply industry announced the necessity to augment its annual surpluses to provide additional contributions towards financing its capital programme. Further increases during the current year in wages, freight charges, interest rates and the price of coal, have prevented the industry from achieving that aim.

The Central Electricity Authority consumes 40,000,000 tons of coal a year, and it points out that coal accounts for two-thirds of the electricity generating costs. The latest increase in coal prices would therefore have necessitated, in the normal course, an advance in tariffs generally in order to preserve at its present level the surplus hitherto achieved by the industry. Nevertheless, the Authority considers that the area boards should avoid, for the present, increases in their tariffs despite the severe strain that this course is likely to put upon them. Apart, therefore, from the automatic increases which apply to those consumers whose charges are subject to a coal price variation clause, tariffs generally will be maintained at their present level.

The Authority says that the industry's policy has been to keep the price of electricity as low as possible against a background of rising costs, but, before the announcement of the last coal price increase, proposals to raise tariffs had been made by the South Wales, Yorkshire and North Western Electricity Boards. Now, the C.E.A. has asked these boards to suspend action on their proposals. The C.E.A. ended its announcement by saying that the whole financial position of the industry and the policy to be pursued would be specially reviewed before the end of the current financial year on March 31st next. It is proposed to maintain price stabilisation at least until that date.

### Technical Development and Full Employment

Some comments on technical development in industry in relation to full employment were made by Dr. Alexander Fleck in his chairman's address at the annual general meeting of Imperial Chemical Industries, Ltd., in London, on Thursday of last week. Dr. Fleck said that, with full employment, it was self-evident that any broad advance in standards of living must depend upon a reduction in human effort relative to the results achieved. In general, that could only come by applying new methods, of which electronic equipment and servo-mechanisms were recent examples.

Automation, Dr. Fleck emphasised, was not new in so far as his company was concerned, but was merely the continuing extension of a process which had for long been a normal feature of its operations. In the industry he represented, it was not considered that the changes brought about by automation were revolutionary, nor was it thought that they were likely to cause unemployment or other major difficulties. The steady growth of employment which had taken place in his company, Dr. Fleck said, confirmed that view, and for the country as a whole he would go further. Employment would only be maintained if British industry kept abreast of the world in technical efficiency. This meant not only the extension of automation, but continued heavy capital expenditure.

Dr. Fleck went on to point out that progress must involve change. With the current high rate of technical advance, he said, it must be recognised that the nature of work was itself changing, with a need for greater skill and intelligence in every kind of industrial activity. Nevertheless, he added, because those developments could only be applied gradually, he believed it was possible for managements to ensure that the necessary adjustments were so made, and so timed, that individual hardship was avoided or, at least, minimised. It was for management and the leaders of organised labour to explain fully what was taking place, so that progressive changes were made as smoothly and effectively as possible, to the benefit of all.

### Recruitment and Training of Young People

It will be recalled that last January the National Joint Advisory Council set up a committee with the following terms of reference :—" To consider the arrangements for the training of young workers in industry, with particular reference to the adequacy of intake into apprenticeship and other forms of training, in the light of the expected increase in the number of young persons entering employment and the need to ensure an adequate supply of trained workers for future needs." The committee now wants evidence about the working of the apprenticeship system and other forms of training. A questionnaire is being sent to all employers' and workers' organisations, and, in addition, any person or organisation who wishes to do so is invited to submit evidence. Such evidence should be sent, in writing, to Mr. K. H. Clucas, Ministry of Labour and National Service, Ebury Bridge House, London, S.W.1, not later than October 31st. The committee says that it would help if the intention to submit evidence was notified not later than July 31st.

### Iron and Steel

There was a slight fall in the rate of British steel production during May. Output averaged 396,400 tons a week, which represented an annual production rate of 20,612,000 tons, compared with a rate of 20,884,000 tons in May last year. The Iron and Steel Board says that the decline is explained by the fact that the Whitsun holiday occurred in May, and also because of a ban on overtime by maintenance workers at some plants. Pig iron production in May averaged 246,500 tons a week, and was thus at an annual rate of 12,820,000 tons, compared with a rate of 12,574,000 tons a year earlier.

An inquiry into the stock situation at the end of the first quarter of this year showed that consumers' and merchants' stocks of finished steel amounted to 3,924,000 tons, or 7·6 per cent more than at the end of last year. This inquiry, it is stated, has enabled the Iron and Steel Board to assess the division of the increase in steel supplies in the first quarter of this year as between that used for further stock increases and that for additional consumption. The Board's figures indicate that home deliveries of finished steel, including imports, at 3,865,000 tons in the first quarter, were 12·8 per cent higher than in the corresponding period of last year. The use of steel, however, increased by only 6·5 per cent, as out of the total additional deliveries of 440,000 tons, 278,000 tons went into stock. The Board says also that steel deliveries to home users showed a still greater increase in April, when they were 16·3 per cent higher than in April last year. The major part of the additional supplies went to the constructional and other engineering industries.

### Transfer of Redundant Workers

The Minister of Labour, Mr. Iain Macleod, was asked last week it he could specify the measures which the Government was taking " to ease the process of transfer for the individual worker who may be affected by automation or by the Government's economic policy." In his reply, the Minister stated that the Government's most important assistance to a worker who became redundant was to help him to find fresh employment, if possible without any intervening period of unemployment. If employers would co-operate in giving as long notice as possible and in providing facilities for their workers to register in advance, the service of the employment exchanges could be used to the best advantage.

With the current level of employment, the Minister continued, his view was that the country did not face any large-scale geographical redistribution of labour, but there must be from time to time a considerable change of jobs and some of those changes might involve transfer to other districts. The Minister went on to explain that, under the Employment and Training Act of 1948, he had powers to facilitate the transfer of workers to other districts and to provide training. Facilities for advance of fares were available in all parts of the country and workers transferring from areas where prospects of employment were poor were eligible for free fares and in appropriate cases for lodging allowances. The various arrangements, together with the assistance offered by employers themselves, had met the need, the Minister thought, up till now. But, he said, he was " keeping the adequacy of all the arrangements under review."

### Wholesale Prices

According to statistics compiled by the Board of Trade, the basic materials price index rose by 0·6 per cent between April and May, mainly because of higher prices for raw cotton, raw wool, and home-produced steel scrap. It will be recalled that the controlled maximum prices for steel scrap went up, on average, 25 per cent at the beginning of May. The basic materials price index (June 30, 1949=100), which excludes fuel and covers " non-food " manufacturing industry, stood at 155·8 at the end of May. The index for materials used in the mechanical engineering industries was 177, and in the electrical machinery industry 189·7. For materials used in building and civil engineering, the price index was 141·7 at the end of May.

Commenting on price movements, the Board of Trade says that the index for materials used in the electrical machinery industry fell by 2·8 per cent in May. This was mainly the result of lower prices for various brass and copper items. By contrast, the index for materials used in mechanical engineering industries rose by 0·6 per cent. Higher prices for iron and steel, which carry 77 per cent of the weight in this index, more than counterbalanced the reduced prices for non-ferrous metals.

### Visual Aids

The British Productivity Council has published a pamphlet, entitled *Visual Aids*, in the belief that the information which it presents will stimulate the greater use of " visual techniques " in industry. Many people's receptivity to the written or even the spoken word is limited, the Council says, and no one concerned in the productivity campaign, it is urged, can afford to neglect visual aids to communication and understanding. The pamphlet deals with " indirect " visual aids, such as slides, film strips, episcopes, overhead projectors and films. Its observation about the film is that it is by far the most versatile of all visual methods. There is also a section dealing with direct visual aids, in which reference is made to flannel boards and models. A final section of the pamphlet is entitled " Putting Up a Good Show." There, it is observed that " an essential link in all visual communication is that between the material and the audience, and often too little attention is given to it, with the result that much of the money and effort which have gone into the preparation of the material are wasted." Finally, the pamphlet explains that the British Productivity Council (21, Tothill Street, London, S.W.1) is prepared to advise on any question connected with visual aids, particularly their planning and use.

# Paris Meeting of the Iron and Steel Institute

DURING the period June 5th to 13th, a special meeting of the Iron and Steel Institute took place in Paris, on an invitation from the Chambre Syndicale de la Sidérurgie Française and the Société Française de Métallurgie.

Members and their ladies were given a very cordial welcome, at a reception held during the morning of June 5th at the Chambre de Commerce de Paris, 27, Avenue Friedland, after which luncheon was taken abroad a Seine pleasure steamer.

In the afternoon, a plenary opening session was held in the Grand Amphithéâtre of the Sorbonne.

Monsieur Jean Raty, president of the Chambre Syndicale de la Sidérurgie Française, in welcoming the Iron and Steel Institute, referred to his predecessor and friend, the late Pierre Ricard, whose work on behalf of the French iron and steel and foundry industries and in the Conseil National du Patronat Français was well known to all, and who had done so much to strengthen the bonds between France and Great Britain.

In his reply, Dr. H. H. Burton, president of the Iron and Steel Institute, recalled the manifold contributions to metallurgy made in France by Floris Osmond, Henry Le Chatelier, Professor Albert Portevin, and many others; nine distinguished Frenchmen, said Dr. Burton, had been awarded the Bessemer Medal. He then presented the honorary membership of the Institute to Monsieur Raty and to Monsieur Henri Malcor, president since their foundation of the Centre de Documentation Sidérurque (C.D.S.) and of the Institut de Recherches de la Sidérurgie (I.R.S.I.D.). Dr. Burton then announced the election as honorary vice-presidents of Monsieur Eugène Dupuy and Baron Walckenaer, the president of the Société Française de Métallurgie. Since Professor Portevin had already received all the honours which the Institute could bestow, Dr. Burton continued, he would present him with a portrait of Sir Henry Bessemer.

After Baron Walckenaer had spoken in reply, Dr. Biers read greetings from the American Institute of Mining and Metallurgical Engineers, and from the American Society for Metals. Monsieur Marcel Froument, president of the Société des Ingenieurs Civils de France, then introduced Monsieur Georges Delbart, technical director of I.R.S.I.D., who spoke to the theme "Sir Henry Bessemer, a born inventor and far-sighted man of business."

## Sir Henry Bessemer

Although Sir Henry Bessemer's work had been fully described before, said Monsieur Delbart,* his own interest in research made him grateful for this opportunity of depicting the life of that independent industrial researcher, and to dispel some misunderstandings still current among many people who were interested in research and its organisation. The speaker then referred briefly to the biographical details of Bessemer's life. Henry Bessemer, born on January 19, 1813, was the son of Anthony Bessemer, who, after studying mechanics in Holland, and living for some time in Paris, had, in his twenties, settled in Charlton (Hertfordshire) and had started a type foundry there. He was the originator of several interesting inventions, and it was from him that his son learned the essentials of the art of metal founding. At the age of seventeen, Henry Bessemer came to London, well versed in design and mechanics. His first inventions, relating to electrolytic coating of articles with copper and to metal stamping, brought him some fame and much experience, but no money. These attempts were followed by inventions in vacuum casting, type-setting and the efficient cancellation of postage stamps. It was many years before this last invention which had been refused by the authorities, was eventually applied by them. It led to substantial savings by the Treasury, but as it had not been patented, Bessemer received no financial reward. Much later, however, he was on this account to be made an officer of the Legion d'Honneur, and to receive a knighthood.

Bessemer's first lucrative invention was the mechanical manufacture of bronze powder for gilding, to be followed by others relating to the manufacture of rolled glass, the manufacture and cutting of optical glass, the silvering of mirrors, and the extraction of sugar from sugar cane. When the Crimean War broke out, Bessemer offered his invention of a rotating projectile to Napoleon III, but without success, as the artillery reports declared that no cannon was available to fire it. This gave him the idea to search for means of improving the quality of the metal used in the construction of gun barrels. Eventually, on August 11, 1856, he announced his method for converting iron into steel, at the Cheltenham meeting of the British Association for the Advancement of Science. After this, he made several further inventions, of which the most unlucky and costly one was that of a stabilised cabin, to be fitted to passenger vessels. The doctors now advised Bessemer to relax; he retired to his property at Denmark Hill and devoted much of his efforts to improving his residence and its garden, where at the time of his death on March 15, 1898, he had begun to construct a telescope of novel design.

Returning to Bessemer's principal work, Monsieur Delbart proceeded to show the evolution of his ideas. It was on January 10, 1851, less than one month after the visit to Napoleon, that Bessemer lodged his first patent. Having at first tried to improve the melt by adding iron, he next had endeavoured to refine it by placing air tuyères under the firebox of the furnace, and had observed that the oxydising action of the blast rendered the iron malleable. In July, 1855, he had experimented with melts in a 40-lb crucible, with the assistance of his future father-in-law, W. D. Allen. He inserted a clay tuyère into the molten metal and applied an air blast, obtaining soft malleable steel. In his patent of October 17, 1855, no mention was made that external heating was unnecessary. The patent of December 7, 1855, prescribed a blow with steam, followed by hot air, the steam cooling the melt. A further patent, of January 6, 1856, introduced a revolving crucible, on the walls of which the metal, thinly spread by centrifugal force, was to be subjected to an upward air blast through the centre of the crucible bottom. In this way Bessemer had sought to obtain uniformity of the product. Single or multiple lateral tuyères were also mentioned in that patent. Lastly, the patent of March 15, 1856, proposed multiple tuyères in the bottom, blowing with cold air, but without as yet excluding the use of steam, an oscillating converter, and the use of carboniferous material to counteract any excessive oxidation. In his communication of August 12th of that year, Bessemer had no longer mentioned steam, but a blast of compressed cold air only, the heat generated by the reaction being sufficient to maintain the metal in the molten state.

Five British works had obtained licences for this process, Bessemer receiving £27,000. But for obscure reasons, the steel produced turned out to be porous, brittle and hot-short. Only when G. F. Göransson, who had obtained the Swedish and Norwegian rights, reduced the air pressure and increased the volume, was the first successful Bessemer steel produced under commercial conditions. This had been on July 18, 1858. In the meantime Bessemer had started a steelworks at Sheffield in partnership with Galloway, Longsdon and Allen, his father-in-law, but had had little success with his method. It was not until he discovered that the iron he used contained excessive amounts of phosphorus that a marketable quality of steel was produced. On May 10 and 17, 1859, he described his process before the Institution of Civil Engineers, showing samples of his steel. In the original process the carbon content of the iron had to be moderate and phosphorus and sulphur had to be low. Later, in 1872, Geo. S. Snelus succeeded in dephosphorising the iron with the help of a converter lining made from burnt limestone which was not, however, sufficiently resistant. The problem of devising a resistant basic lining was eventually solved by Sidney Gilchrist Thomas in 1877. Meanwhile, Bessemer improved the design of the converter until it reached the form which is still in use at the present time.

Monsieur Delbart then gave a brief survey of the development of the Bessemer process from 1860, when a few tons were produced, until the present time, when, in 1954, production in the O.E.E.C. countries amounted to 24,000,000 tons (of which 23,880,000 tons were Thomas steel), while the U.S.A. produced over 2,500,000 tons of acid Bessemer steel.

In turning to Henry Bessemer's personality, the speaker described him as a man who had a flair for what was required and who would push towards his objective with imagination and enthusiasm, observing, listening, not waiting for help from anybody. Contrasting the isolated feats of discovery and development, which was what the great inventions essentially were, with the slow process of putting an idea into practice and perfecting it—the first often the achievement of complete newcomers in their field, the second the work of trained specialists—Monsieur Delbart concluded that both were equally necessary.

As to the work done by committees, while many of them were justly criticised, he himself had experience of some which, although they were perhaps a minority, were models of efficient collaboration, Bessemer himself, who would probably have made an unsatisfactory member of the rank and file, must have been, in his role as president of the Iron and Steel Institute from 1870 onwards, an excellent chairman of committees. And he certainly needed to collaborate with many people as much in order to freshen his ideas as to rectify his mistakes. According to his own words, "few men had made more mistakes than he and probably few had learnt so much because of them." His guarantee that steel would be produced from any kind of iron was one, his view that the process could be operated by unskilled hands was another. His initial knowledge of metallurgy, as Bessemer himself freely admitted, was confined to what an engineer could not help but observe in a foundry or forge; but on the other hand, this gave him the advantage of freedom from preconceived or false ideas. Neither his own mistakes nor the contributions of others detracted in any way from his status, which had been well established, in France, through the writings of Henry Le Chatelier and Jean Cournot. This could be said without diminishing the achievements of his collaborators and of those who followed him.

## Technical Sessons

During the mornings of June 6th and June 8th, a number of technical sessions were held at the Chambre Syndicale de la Sidérurgie, 5 bis, rue de Madrid. The following papers were presented for discussion:—"Instrumentation in Steelworks," by G. Husson and J. Leroy[1]; "Studies on a 10 cwt Arc Furnace," by W. H. Glaisher, M. Preston, and J. Ravenscroft[1]; "The Effects of Gravity on the Solidification of Steel," by B. Gray[2]; "Applications of the Electron Probe Micro-Analyser," by C. Crussard and J. Philibert[1]; "Studies on a Model of the Aerodynamics of a Maerz Type Open-Hearth Furnace with Preheated Gas and a Comparison with Siemens and Terni Furnaces," by G. Husson, G. Cohen de Lara, and R. Durand[3]; "Desulphurisation of Liquid Pig Iron by Blowing with Lime Powder," by B. Trentini, L. Wahl, and M. Allard[3]; "Sulphur Partition between Gas, Slag, and Metal Phases under Iron and Steelmaking Conditions," by E. T. Turkdogan[4]; "A Study of Impact Tests and the Mechanism of Brittle Fracture," by C. Crussard, R. Borione, J. Plateau, Y. Morillon, and F. H. Maratray[3]; and "Some Effects of Heat-Treatment and Microstructure on the Transition Temperature

* For the full text, see *Revue de Métallurgie*, Special issue, June, 1956, page 1; also *Journal I.& S.I.*, June, 1956.

of a 0·24 per Cent Carbon Steel," by G. Burns and C. Judge.[5]

### Excursions

Much interest was centred upon the visits to industrial establishments and centres of research, of which a large and varied programme had been organised. Of these visits only a few are selected here for description.

### Centre Technique des Industries de la Fonderie

The French foundry industry is organised in eight groups (castings from patterns, shell moulding, castings for hydraulic and public service purposes, steel castings, malleable castings, castings in bronze and brass, light metals, and pressure die castings). The industry produces some 1,500,000 tons of castings of all kinds per year, of a value of about 100,000 million francs. Its 2400 factories employ over 100,000 workers.

Founded originally in 1942 with a small staff which acted as consultants to the industry, the Centre Technique des Industries de la Fonderie did not begin to acquire its present size and importance until after 1945. As the main purpose of the Centre is to assist industry with its day-to-day problems, its activities are carried out in a number of laboratories distributed all over the country. These are ten in number, situated at Paris, Rourbaix, Charleville, Nancy, Saint-Didier, Marseille, Bordeaux, Rennes, Lyon and Rouen. The central laboratories, which were the subject of the visit, are situated at Sèvres, near Paris. There, in addition to *ad hoc* research for the Paris region, fundamental studies are being carried out. The Institute also maintains a scheme for marks of quality (" labels " and " Marques NF ") guaranteeing conformity with the French industrial standards, of a variety of products ranging from castings to heating appliances. At Sèvres there is a staff of sixty, of whom about half are scientists or engineers. Altogether, the Centre employs some 350 people.

The research projects which have been undertaken at Sèvres are concerned with all aspects of foundry technology, with metallurgy as well as with workshop techniques and installations. One of the main current jobs is to maintain and bring up to date the collection of moulding sands from all over France, consisting of samples from over 250 deposits. The results of tests of such samples are published in brochures issued according to regions. This scheme has led to substantial savings in transport charges to the industry.

In the laboratories, which have been constructed during the last six years, some very modern equipment is in use. As an example may be mentioned an automatic spectrometer made by Cameca, 103, Boulevard Saint-Denis, Courbevoie, which at the present time carries out forty analyses a day of aluminium and zinc alloys. The instrument is fitted with interchangeable templates each mounting a number of cam stops. These stops are set along the template in positions corresponding to the principal spectral lines of the constituents under test, and govern the motion of the photometric head. The flanks of stops act as cams and operate a lever which controls the sensitivity of the instrument at each setting. Movement of the spectrometer is fully automatic and its output is recorded on a paper band, giving directly the percentage of each constituent.

The foundry is constructed on two levels, ground floor and basement. In this way the sand stores could be extended below ground beyond the area covered by the building, the size of which was limited by town planning regulations. Two cupola furnaces of 20in and 10in diameter, with basic and acid linings respectively, have been installed, and there are five crucible lift-out furnaces. Further equipment is to be provided.

Another wing of the building contains the machine shop and samples store, as well as equipment for carrying out mechanical tests.

Trials of heating appliances are being done in a converted, older building, which faces the main laboratory block. Here, an appliance under test is placed on the platform of a sensitive weighing machine which permits the rate of combustion to be determined. By measuring the air flow to the chimney, the flue gas composition and the flue heat loss, the efficiency may be calculated from the difference between thermal input and the losses. Modern appliances achieve efficiencies of 70 per cent or over.

The Centre Technique de la Fonderie comes under the law of July, 1948, regarding technical centres for industry. On its board of fourteen are three scientists, seven representatives of the employers, and four of the employees. The Government retains the right to veto decisions of the board.

### Societe Metallurgique de Normandie

On Thursday, June 7th, members and their ladies had an opportunity of seeing the works of the Société Métallurgique de Normandie, at Mondeville, near Caen, as well as visiting Bayeux and the Normandy battlefields. Built originally just before World War I, the Mondeville plant is situated about two-and-a-half metres from Caen, on a plateau rising some 130ft above the River Orne. During the D-Day landings in Normandy in June, 1944, and the subsequent battles, large-scale destruction resulted in the works from aerial and artillery bombardments, and from German demolitions. On December 11, 1950, production was resumed with the coming into operation of one blast furnace. To-day the works has attained and even surpassed its pre-war achievements.

The economics of the Mondeville works rest on two factors : the supply of iron ore from the mines at Soumont, about 16 miles to the south, and the shipment by sea of coal and of a large proportion of the finished products. The works are joined by railway to the Soumont mines, and to the port of Caen which is on the Ouistreham-Caen ship canal. Limestone for use in the blast furnaces is obtained from a quarry at Aucrais, on the railway line to Soumont.

The coking plant has a daily throughput of 1500 tons of coal, and consists of three batteries of about 100 ovens. Auxiliary equipment is used to recover the distillation by-products, ammonia, benzol and tar. Any gas not consumed in the plant itself is delivered to the French National Grid for use in the region. A gasholder of 32,700 cubic yards capacity serves to balance the supply.

Each of the two blast furnaces has a capacity of 600 tons of pig iron per day. The ore is an iron carbonate which after pre-roasting at the mine, contains about 45 per cent of iron. The furnaces are charged automatically by means of hoppers elevated by vertical hoists. They are tapped every three hours, the pig running into the ladle cars for direct conveyance to the steel furnaces. A casting machine enables pigs to be cast mechanically.

The slag is air cooled after tapping, crushed and screened, and used as railway ballast, gravel and grit. Part of it is granulated by water-quenching and supplied to a cement factory situated within the precincts of the works.

A concrete building over 300 yards long houses the open-hearth steel plant, the basic Bessemer plant, and two mixers of 800 tons and 500 tons capacity, respectively. After mixing, the iron goes to the Bessemer converters, of which there are four, each of 25 tons capacity. The open-hearth plant comprises three furnaces heated by blast furnace and coke oven gas, having a capacity of 50 tons each. A fourth furnace, of 60 tons capacity, will come into operation later. The charges are turned into ingot moulds, either on trucks or in pits. The ingots, weighing about 4 tons each, are stripped in the rolling mill plant.

Lime required for processing the steel comes from two gas-heated lime-burning kilns, each with a daily output of 80 tons. The basic slag obtained is ground and sold as phosphatic fertiliser. By the side of the steel works a special brick-making plant has been erected to supply the dolomite bricks needed for the converter linings.

In the rolling mill plant, soaking pits are provided for the ingots delivered from the steel plant. A roughing train driven by a 15,000 h.p. motor, feeds to the semi-finishing mill, which has three stands with 35in rolls, and is also driven by a 15,000 h.p. motor. Nearly 40,000 tons of merchant shapes (e.g. round billets for seamless tubing) or semi-products are turned out each month.

The finishing sections include a rod mill, producing wire of 0·2in to 0·5in diameter from billets 2in by 2¼in by 30ft. long. This is a continuous mill with nineteen stands in line, having a capacity of about 15,000 tons per month when working three eight-hour shifts per day.

A second mill produces chiefly round bars of ¼in-1¼in diameter, and has a 280ft long cooling table, while a third mill is used for medium sections and heavy merchant rounds.

The rolling mill plant covers over 15 acres, and its equipment includes thirty travelling cranes of 5 tons to 50 tons capacity.

About 2500 tons of wire is produced in the wire-drawing plant, which receives coils of 0·2in wire from the rolling mill and draws them to the required thickness in a train of sixteen multiple drawing frames. The galvanised product can be made into barbed wire in fifteen barbing machines. Further equipment is provided for making baling wire, welded wire netting, and wire nails.

Electric power installed at the Mondeville works totals 65MW, supplied by five 4MW sets driven by gas engines working on blast furnace gas, and three turbo-alternators, the largest of which is of 15MW. There are four boilers, of a total capacity of 120 tons to 150 tons of steam per hour ; normally these are fired by blast furnace and coke oven gas. Gas engine and turbo-driven blowers supply blast air for the iron furnaces and the basic Bessemer plant.

As the Mondeville plant is situated in a mainly agricultural part of France, maintenance has to be carried out to a very large extent on the spot. Facilities include an iron, steel and bronze foundry, a machine shop, forging and boiler shops, and an electric workshop where all repairs and reconditioning of the electrical equipment, in particular of electric motors, can be carried out. The maintenance shops cover an area of nearly 2½ acres.

The works railway system has a total length of 44 miles, including the 31 miles of the port and mineral lines. There are over fifty locomotives, tractors and travelling cranes, and over 500 wagons ; a central depot with repair shops for engines and wagons is provided. At the Hérouville basin of the port of Caen the company has a jetty for discharging colliers, and a 984ft long quay used for shipping steel and steel products. Handling equipment includes eight cranes of 3 to 8 tons capacity, and permits the discharge each day of 4000 tons of coal and the shipment of over 1000 tons of steel.

The Société Métallurgique de Normandie employs 4900 people at Mondeville, and a further 700 at Joumont. A great part of the staff is housed on an estate extending over the neighbouring communes of Mondeville, Gibervilles, and Colombelles. This estate was practically rased to the ground during the War. Over 1300 dwellings have so far been rebuilt, together with schools, a public hall, library, hospital, and a sports stadium.

### Testing Station of S.N.C.F. at Vitry-sur-Seine

The testing station of the Société National des Chemins de Fer Français was visited on the afternoon of Friday, June 8th. The locomotive test bed was constructed in 1933, and has served as a model for the corresponding installation at Rugby, built in 1948. It comprises a number of rollers, which support the driving wheels of the engine under test and which are carried in pedestals clamped to heavy slideways let into the floor. The rollers are coupled to Heenan and Froude dynamometer water brakes, while the drawbar pull is balanced by an oil pressure cylinder. The test for each particular speed and drawbar pull occupies about an hour. Speed and drawbar pull are transmitted to an Amsler integrating table, where these quantities, together with the horsepower and the total work done are continuously and automatically recorded.

There is also a testing bed for carriages and goods vehicles, where hydraulic forces of up to 250 tons can be exerted on the buffers or other parts of the structure, any permanent deformation being detected by means of strain gauges. It has been established that in order to be satis-

factory in service vehicles must be able to withstand at least 200 tons in these static tests. Equipment for testing brakes is available in the form of a heavy flywheel, which is driven through a gearbox by a large motor, and to which the carriage or the locomotive wheel, with its brake, are coupled. Brake pressures of 75 kg to 90 kg per square centimetre are used (the higher value for locomotives), the authorities claiming that higher values will result in damage to the track.

The technical programme of the meeting was rounded off by further items of a social nature, which were much enjoyed by the participants. In the evening of June 5th a reception was held at the Louvre, and on the following evening members and their ladies were able to attend a performance of Verdi's "Othello" at the Théâtre National de L'Opéra. On the evening of June 8th a banquet took place at the Orangerie of the Palace of Versailles, by invitation of the Chambre Syndicale de la Sidérgie Française and the Société Française di Métallurgie, followed by illuminations and a dance. A number of visits at the weekend to places of cultural interest in the vicinity of the capital concluded the meeting in Paris. The remaining time until the 13th was devoted to visits to a number of important iron and steel undertakings in Central France and in Lorraine.

REFERENCES

[1] Published in *Journal, I. & S.I.*, May, 1956.
[2] *Ibid.*, April, 1956.
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[5] *Ibid.*, March, 1956. All papers have appeared in a special issue of *la Revue de Métallurgie*, June, 1956.

## Large Propane Container

Our accompanying illustration shows one of two spherical propane containers of 800 cubic metres capacity, each built for Bataafsche Petroleum Maatschappij by Rotterdamsche Droogdok Maatschappij, of Rotterdam. The internal diameter of the container is 11·5m, and it is constructed from HIIA steel to DIN 17155, with a uniform wall thickness of 42mm. Designed for a working pressure of 15 atmospheres gauge, it had to withstand a test pressure of 21 atmospheres gauge and to be subjected to 100 per cent X-ray inspection of all seams, according to the requirements of the Dutch surveillance organisation, the Dienst voor net Stoomwezen. The steel employed is non-ageing, and has the characteristics of good impact strength, its impact qualities being satisfactory down to temperatures of −75 deg. Cent.

Each container was constructed from eight horizontal rings plus a bottom and top portion. The elements of the shell were formed cold, without subsequent normalisation. Eight equally spaced wind-braced columns support the sphere, the heads of the columns being box structures connected by butt welds, and flange mounted on the tops of the columns themselves.

Each of the horizontal rings was built up from eight segments, which had been cold-formed in a press to a template and trimmed by flame cutting away the surplus. The edges were then chamfered by flame cutting and ground. The closing segment of each ring was trimmed after the remaining ones had been welded on the shop floor, using X-seams with 60 deg. chamfer. For the horizontal seams between rings, K seams were used which varied according to their position on the sphere. Basic electrodes of the type "OK 48" and direct current was used.

For ease in transportation the container was provided with a pedestal base, on which it was erected in the shop. After the sphere had been transported over a greased slipway to the shore and from there by means of a floating crane across the Lek, it was taken to its site at Pernis, again on a greased slipway. After it had been placed in position on seven columns the pedestal base was removed and the eighth column inserted.

## Swedish Atomic Power

The Swedish nuclear energy corporation, A.B. Atomenergi, is planning to erect a material testing reactor with a thermal output equivalent of 20MW at the Studsviks plant, to be completed in 1959. When greater amounts of plutonium are available, i.e. in about 1965, a regenerative reactor may be constructed. The corporation's programme includes a 90MW district heating plant, a combined district heating and power plant with a thermal output of 77MW and an electrical output of 13MW, and a condensing power station rated at 77MW. The first of these could be finished during 1960.

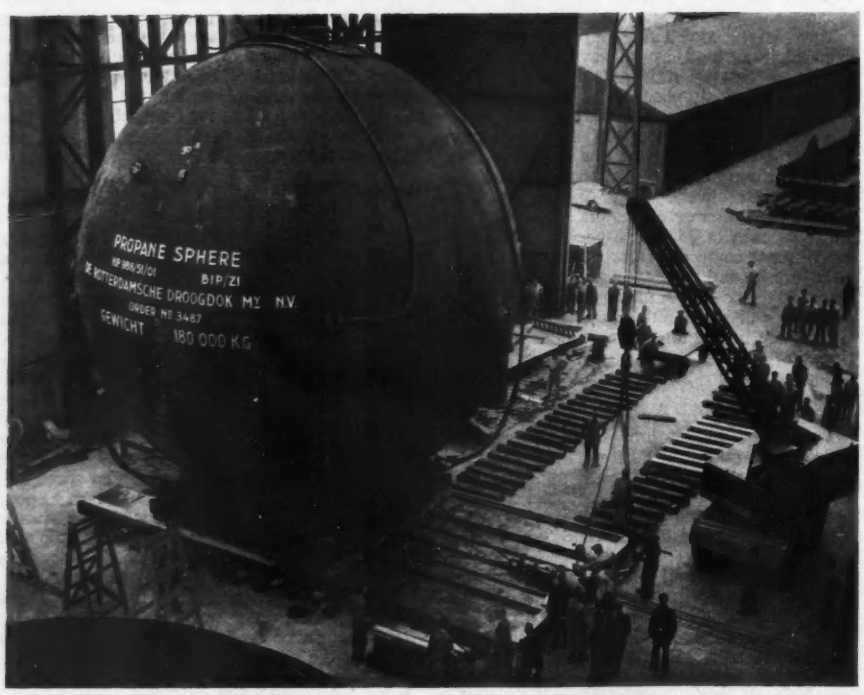
The first condensing power station of 100MW may be expected to be in operation by 1963. A further three or four plants for urban heating or for industrial process heating could be ready before 1965. Plants operating at 300MW to 500MW would probably not become available before 1967 or later. A national development programme for Sweden's atomic energy, it is considered, would provide for installed capacities of 100MW by 1960 (saving 10,000 tons of coal), installed capacities by the end of the subsequent five-year periods until 1975 to reach, respectively, 800MW to 1000MW, 3000MW to 6000MW, and 6000MW to 12,000MW, and saving 0·1 million 1,000,000 to 3,000,000, and 3,000,000 to 8,000,000 tons of coal.

The position with regard to Sweden's consumption of energy is that the rate of increase after the second world war has amounted to 5 per cent per annum. Last year's consumption was equivalent to 24,000,000 tons of coal, to which hydro-electric power made a contribution equivalent to just over 3,000,000 tons of coal, and Swedish fuels contributed the equivalent of 4,000,000 tons of coal. More than 73 per cent of Sweden's demand for energy had to be covered by imports of oil, coal and coke, at a cost last year of 1749 million kroner.

Even if it is assumed that the rate of growth of the consumption will fall to 4 per cent per annum, the annual consumption in 1975 will still be equivalent to 52,000,000 tons of coal. Only 9,000,000 to 10,000,000 tons will be replaced through the expansion of hydro-electric power. On the other hand, there are available in Sweden deposits of uranium ore containing more than 1,000,000 tons of uranium. Although low-grade, these ores can be utilised and by present-day techniques could give a minimum quantity of energy corresponding to 1500 million tons of coal.

As regards the cost of production of atomic energy compared with that from traditional fuels, it is thought that initially nuclear electricity will cost from 2 to 4 öre per kilowatt-hour to generate, as compared with 2·5 to 3 öre per kilowatt-hour for hydro-electric power, and 5 to 7 öre per kilowatt-hour for coal or oil-fired condensing power stations. For the production of heat, atomic stations can compete with traditional fuels, with costs being of the order of 1·2 to 2·4 öre per kilowatt-hour for atomic fuel, and 2·0 to 2·6 öre per kilowatt-hour for oil or coal-firing stations.

There is a certain amount of opposition to the proposal in the report on atomic energy that responsibility for the development of atomic energy for peaceful purposes should be concentrated entirely in the hands of the Government controlled A.B. Atomenergi. This opposition comes notably from the geological survey of Sweden, the 1951 Fuel Research Committee, and the Water Power Board, who fear that such concentration will not be conducive to the required rapid development of atomic power.




**An 800 cubic metre propane container, weighing 180 tons, ready to be transported over slips to the quayside**

## "Achema" Congress and Exhibition, 1958

The "ACHEMA 1958," the twelfth Chemical Apparatus and Equipment Congress and Exhibition, which will take place in Frankfurt/Main during the period May 31 to June 8, 1958, is being organised by the Dechema Deutsche Gesellschaft für Chemisches Apparatewesen. For the first time nuclear physics and technology will form separate sections in the exhibition. It is hoped that this arrangement will facilitate the exchange of ideas and experiences in these fields.

Some 10,000 specialists and experts from Germany and abroad will, it is anticipated, attend the congress which is being arranged in the following groups: nuclear physics and technology, laboratory technology, measurement and control technology, operational technique, pumps and fittings, materials, chemical technology, and research and literature. In view of the success of last year's congress and exhibition, over 47,000 square metres out of a total of 60,000 have already been taken.

The *Achema Yearbook*, 1956/1958, which lists European chemical apparatus and equipment, will appear in four languages (English, French, German and Spanish), and is intended as an introduction and preparation for the congress itself. Invitations and a provisional programme will be issued during the second half of 1956, and can be obtained free of charge on application to the Dechema Deutsche Gesellschaft für Chemisches Apparatewesen, Frankfurt/Main 7, Rheingau-Allee 25, Dechema-Haus.

# Heavy Extrusion Press Plant at Halethorpe, Maryland

No. II—( *Concluded from page 691, June 15th* )

*The Kaiser Aluminum and Chemical Corporation recently completed, at a cost of 25,000,000 dollars, a heavy extrusion press works addition at Halethorpe, Maryland. This factory is now one of the major American heavy aluminium alloy extrusion facilities and was conceived, constructed and financed as part of the heavy press programme of the U.S. Air Force. The plant installed includes two 8100-ton extrusion presses, two semi-continuous "D.C." billet casting machines and various ancillary equipment. Together with five older presses and four new presses, to be installed later this year, the Halethorpe works will ultimately have an annual extrusion capacity of about 70,000,000 lb.*

## Special Extrusions

In addition to the production of conventional solid and tubular extrusions, the Halethorpe works is also active in the field of special extrusions. The 8100 ton presses are designed so that a tapered mandrel can be used to extrude a tube having a tapered wall thickness, with increasing inside diameter. The mandrel can be attached to the ram or can be floating. The new presses at Halethorpe are equipped with a unique sliding member within the ram to which the mandrel can be attached. This mandrel manipulator permits the movement of the mandrel independent of ram movement and allows the production of tubular shapes with tapering or stepped interior configurations. Generally, the mandrel method is used only when extruding symmetrical tubular shapes. The works can also extrude many tubular shapes with other than round holes. This is accomplished by using a mandrel of the required cross section. To maintain the critical tolerances required, the ingot is cast with a hole to match the mandrel shape.

Stepped extrusions are to-day considered to be of growing importance in America. They

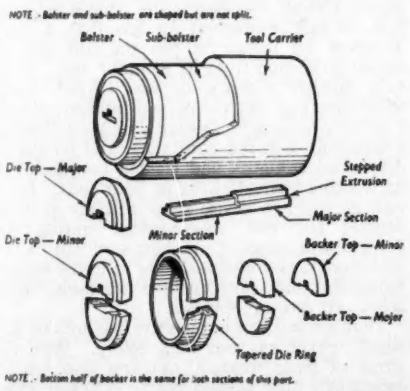



**Fig. 9—Diagram of stepped extrusion die procedure on 8100-ton presses**

are made at Halethorpe by stopping the press when the ingot is only partially extruded, removing the dies and replacing them with dies of large opening. The push is then resumed. The result is an extrusion that has an abrupt change in cross section. Stepped extrusions are usually more costly, as the press must be stopped in the middle of its cycle, increasing cycle time. Nevertheless, stepped extrusions have proved economical for certain aircraft structural parts. Typical applications involve a heavy end, required for attachment, while the rest of the extrusion is of much smaller cross section. Savings are realised in such cases by combining two parts into one, as the machining of mating surfaces and assembly costs are often eliminated. Also, in such an application, less metal is removed when machining a stepped extrusion. Multi-stepped extrusions also offer opportunities to save on basic material costs when parts are machine-tapered at a later stage. As shown in Fig. 9, the step dies are split and held in a tapered ring against the back-up tools. With some step designs the back-up tools must be changed when the die is changed. In this case the back-up tools must also be of split design.

The extreme versatility of the two 8100-ton extrusion presses offers an opportunity for the development of unique extrusion shapes and novel techniques. At the back end of the press the large main cylinder that operates the ram can be controlled within very close limits and independently of the two main cylinders at the centre of the press. By connecting this cylinder to the mandrel when extruding hollow shapes, it is possible to hold the mandrel stationary or move it forward or backwards during the extrusion operation. The mandrel may also be positioned at an angle by a rotating device that operates within an arc of 30 deg. This permits the indexing of the mandrel in relation to the die to hold close wall thickness tolerances on tubes of irregular cross section. The press design permits the use of a flat container for the very wide extrusions used in aircraft, vehicle and architectural design. To accommodate also round containers and the conventional dies used with them, two gate locks were built into each press. This aspect, combined with specially designed tools, now permits rapid die change in the production of stepped extrusions and means corresponding savings due to a faster production cycle.

Wall section thinness in extrusion design may be of critical importance in a given application, such as in integrally stiffened skin for aircraft. To achieve thin sections high pressures are necessary. The 8100-ton force available from each of the heavy presses is more than adequate for extrusions of this kind. The pressure against a solid ingot increases as the ingot diameter decreases. Thus, the two presses develop 137,000 lb per square inch with a 12in container and 50,000 lb per square inch with a 20in container. It follows that thinner sections can be extruded, using a 12in container. A design compromise must, therefore, be reached between extrusion width or diameter and section thinness.

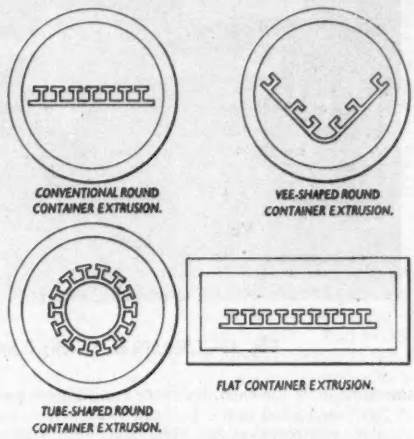



**Fig. 11—Methods of extruding flat, integrally stiffened panel sections**

The following table, showing section thickness *versus* circumscribing circle diameter reflects this basic condition. It should be noted that the maximum circumscribing circle diameter must be smaller than the container diameter.

*Minimum Section Thickness for Various Alloys and Circle Sizes*

| Circumscribing circle, Diameter, inches | Alloy | | |
|---|---|---|---|
| | 75S | 24S | 14S |
| | Inches | Inches | Inches |
| 9¼in ... ... ... ... ... ... | 0·172 | 0·156 | 0·109 |
| 9¼in-11¼in ... ... ... ... ... | 0·187 | 0·172 | 0·125 |
| 11¼in-13in ... ... ... ... ... | 0·250 | 0·250 | 0·171 |
| 13in-15in ... ... ... ... ... | 0·375 | 0·375 | 0·187 |
| 15in-17in ... ... ... ... ... | 0·437 | 0·375 | 0·312 |

When a tubular extrusion is made, using a mandrel, the hole in the ingot reduces the ingot cross-sectional area. Assuming that the mandrel manipulator gear is not employed, and that maximum total pressure is developed, higher unit pressures are possible with mandrel-type tubular extrusions for a given container size than are possible with a solid ingot in the same container. Therefore, an integrally stiffened skin extrusion in the tubular form can have much thinner

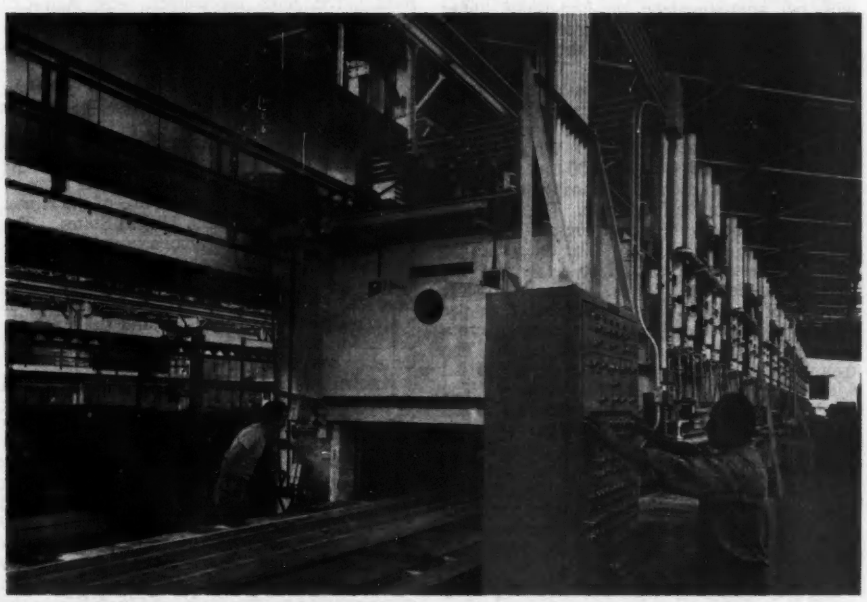


**Fig. 10—"Westinghouse" horizontal roller hearth heat-treating furnace with water flood quench arrangement**

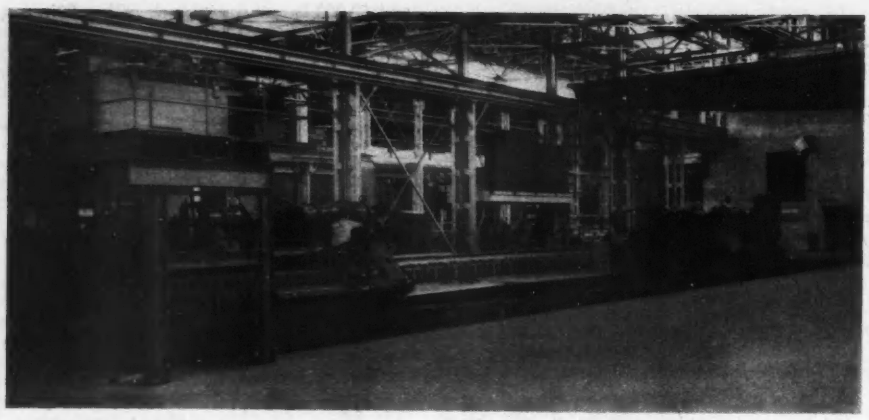


Fig. 12—1,500,000 lb " Loewy " hydraulic stretching and untwisting machine

sections than one extruded from a solid ingot as a " flat " or folded in a " U " or " V."

The combination of thickness and widths obtainable for flat, integrally stiffened, extrusions are governed by the available unit pressures on the various container sizes. It is estimated that the thickness tolerance will be one-and-a-half times normal, due to die spring and change of metal flow conditions throughout the cycle. There will also be some variance in overall width dimensions due to the proximity of the edges of the section to the container wall, which can affect the thickness in this area. As shown in Fig. 11, it is possible to increase the overall width of the section by extruding it as a " V " or " U " configuration, to be flattened after extrusion. The tolerance on thickness dimensions is estimated to be twice normal, due to bending of the section. The transverse flatness deviation of the section is estimated to be 0·008in per inch. Should any ribs happen to fall in the area of the bend in the web, localised departures from flatness opposite these stiffening ribs may occur. This could take the form of a depression or bulge and may be a 0·015in departure from the adjacent areas.

Using the tubing method of producing integrally stiffened panels, it will be possible to obtain substantial increases in widths over the other methods, together with a relatively thin sheet. The thickness tolerance of the skin will be that applicable for the wall thickness of extruded tubing, or approximately 20 per cent. It will be possible to maintain good control of the overall width dimension, as the section will be trimmed to size after flattening. The rib spacing will be approximately one-and-a-half times normal tolerances, and the control of angularity between the ribs and the sheet should be within the normal tolerance of 2 deg. The transverse flatness deviation of the section is estimated to be 0·012in per inch with localised depressions occurring in the sheet at points opposite the stiffening ribs up to 0·010in. With the flat container proposed for the 8100-ton presses it will be possible to extrude sections lying within a 32in wide by 2¾in high rectangle. The minimum thicknesses obtainable are at present estimated to be 0·090in in 75S alloy. The tolerances on web thickness are expected to be within the present standard tolerances. This is possible because of improved flow conditions in the flat container where the die opening extends across the end area of the rectangular ingot. The overall width and rib spacing is expected to fall within the range of normal tolerances. The transverse flatness of the section should also fall within the normal tolerance range with no depressions occurring in the web opposite the stiffening ribs. Due to the increased side wall friction obtained when using a flat container as compared to the round, it is necessary to reduce the ingot length. At the present time the maximum weight of an extruded piece, ready for despatch, is estimated to be 260 lb.

### Ancillary Plant

Following extrusion, the sections may be heat-treated in a " Swindell-Dressler " vertical batch furnace having a capacity of 10,000 lb per charge and capable of handling pieces up to 50ft in length. Alternatively, they may be passed continuously through the Westinghouse horizontal roller hearth furnace illustrated in Fig. 10. This furnace has a capacity of 4000 lb of extrusions per hour and can handle pieces up to 90ft in length. Its hearth is 100ft long and its overall length is 322ft, including the entry and exit tables. At the discharge end there is a flood quench arrangement employing nozzle sprays, capable of emitting up to 30,000 gallons of water per minute. The new works also comprises an ageing and annealing furnace capable of treating a 100,000 lb charge for eight hours at 800 deg. Fah.

In addition to a " Sutton " roller straightening and contour correcting machine and a 500-ton " Farquhar " horizontal straightening gag press, the Halethorpe works are equipped with two exceptionally powerful untwisting units. Fig. 12 shows the 1,500,000 lb hydraulic stretching and untwisting machine which was designed and built by Loewy-Hydropress. It is driven by a 150 h.p. main motor and can handle pieces up to 90ft in length whose diameter can be inscribed within a 24in circle. It is normally used to apply a permanent set of 1 to 1½ per cent to the extruded sections. The mechanical untwisting machine, was designed and built by the Sutton Engineering Company, of Bellefont, Pennsylvania. It has a maximum torque capacity of 3,000,000in-lb, is driven by a 125 h.p. motor, and can handle pieces up to 85ft in length whose diameter can be inscribed within a 24in circle.

At the present time the works is proceeding with a further 6,000,000 dollar expansion programme, and it is expected that by the end of 1956 three 2750-ton extrusion presses and one special 3500-ton tubing extrusion press will be in operation. The latter presses which are self-contained oil-hydraulic machines, are being built by the Birdsboro Steel Foundry and Machine Company, of Birdsboro, Pennsylvania.

# Industrial Symposium on Titanium Applications

IT is generally agreed that, apart from high manufacturing costs, the greatest problem currently facing the American producers of titanium is a lack of sufficiently widespread application of the so-called " wonder metal." So far, one of the most promising fields of application has been in the aircraft industry, and it is therefore of interest to review an industrial symposium which was recently arranged by the Solar Aircraft Company, of San Diego, California, and took place at the firm's Des Moines works in Iowa. The urgent problems besetting such a pioneer user of titanium were brought into sharp focus in this two-day symposium, which was attended by the Solar technical staff and the representatives of five titanium producing mills. The mills represented were Rem-Cru Titanium, Incorporated, Midland, Pennsylvania ; Republic Steel Corporation, Massilon, Ohio ; Titanium Metals Corporation, New York City ; Sharon Steel Corporation, Sharon, Pennsylvania ; and Mallory-Sharon Titanium Corporation, Niles, Ohio.

The importance of the meetings was underlined by the fact that Solar, which has six major jet engine assemblies and numerous detail parts of titanium now in production, is one of the largest users of the metal in the United States. The symposium was primarily concerned with aluminium-vanadium and aluminium-tin alloys of titanium, as well as with the commercially pure product. The interchange of information was marked by complete candour, and the rules for discussion stressed that no one would be quoted by name or company.

Known as the " middleweight champion " in America to-day, titanium is about 60 per cent heavier than aluminium, and 56 per cent as heavy as alloy steels. Its chief asset is a superior strength-weight ratio, which has made it highly attractive to aircraft designers. While it cannot withstand the operating temperatures of jet engine combustion areas, titanium can save enough poundage elsewhere to be almost worth its weight in gold. For every pound trimmed from an engine, 10 lb to 15 lb of structural and compensating weight can be eliminated from the aircraft it powers. The current American prices for the material, despite recent cuts, still range upward from 20 dollars a pound in the finished form, such as sheet and strip. Thus, it was pointed out, despite the fact that some of the titanium alloys discussed at the symposium have been in mill production for less than a year, designers are willing to pay the stiff cost of wresting titanium from its plentiful ores. Practical military urgency, it was agreed, made imperative that both mills and fabricators seek ways to overcome the metal working difficulties inherent in both the pure metal and its alloys, despite uncertainties and lacking knowledge of its working characteristics at both ends. Practical attempts to devise shop methods to compensate for mill shortcomings during the development stages of titanium were laid on the table and frankly discussed. In turn, the visitors reported frankly on their own processing headaches and accomplishments.

Titanium behaves in the shop like nothing any metal worker has ever seen before. With the virtue of basic strength, titanium also has an exceedingly high melting point, 3150 deg. Fah., well above 18-8 stainless steel, which melts at 2250 deg. Fah. This implies the necessity of high temperature in rolling and forming the metal. However, titanium tends to lose strength and become brittle when heated above 1000 deg. Fah. A careful " re-stabilisation " of the metal and alloys, involving costly delays in the production cycle, is necessary to counteract the results of processing heat.

At room temperatures titanium will resist corrosion by almost any chemical condition, including boiling chlorides, nitric acid, strong alkalis, food acids and sea water. But, when melted, this difficult metal combines unhandily with virtually everything, including all the moulds yet devised for pouring castings from it. In between, titanium performance varies with the temperature : at a temperature as low as 300 deg. Fah. it begins to pick up hydrogen, which makes it brittle and from which it can be separated only by vacuum heat-treating. Ordinary industrial processes such as welding and annealing of alloys must, as production engineers have found out, be done in a vacuum or inert gas atmosphere to protect the original characteristics of the metal. Descaling baths, which customarily follow heat-treating, must be carefully controlled to keep their ingredients from

combining with the metal, instead of cleaning it.

Possessed of potential surface hardness comparable to steel, titanium "galls" so readily that all sliding contacts must be avoided. When grinding is attempted, titanium tends to combine with the abrasive material being used. Again, it was brought out during the discussion, titanium is likely to "load up" and clog the tool being used, and the metal, being prone to work hardening, makes the cut so difficult that tools wear down faster than the titanium itself can be shaped. The metallurgists and sales representatives present at the symposium drew upon the extensive research experience of their respective mills to respond to questions on these problems, as well as considerations covering hot and cold forming, methods of preventing titanium from absorbing hydrogen, the practicality of "de-skinning" or removing a few thousandths of an inch of metal from the surface, and the conditions under which titanium must be restabilised by annealing after processing.

At the same time, the symposium brought out, the producing mills are still endeavouring to find a way to roll high-strength alloy sheets which will deviate less than 5 to 8 per cent from true flatness. It was also admitted that under present circumstances properties, such as bend strength and formability, "can be expected to vary" within the individual sheets. Actually, it was stressed, exact knowledge of the metal itself is hampered by lack of technical background. The National Bureau of Standards has not yet established standards for analysis of titanium and its alloys. In the words of one mill executive: "There is no method of analysis for oxygen content—including our own—that I believe is reliable." Meanwhile, routine checking at the Solar works laboratory includes testing each mill heat of incoming materials to determine physical characteristics such as tensile strength, ductility, endurance limit, formability, and grain structure, and the chemical composition.

Thus, lacking accepted reference standards, if Solar's analytical reports differ from the reports coming from the mill, the dispute must be settled by cross-comparison of samples and procedures between the two laboratories involved. The acceptance of or rejection of 70,000 dollars worth of incoming titanium sheet stock can hinge on its meeting the customer's technical specifications. Some of the difficulties in handling titanium, it was emphasised, will diminish as the mills gain more experience in producing it. Some alloys were announced only last spring; the total American output of the commercially pure metal and its alloys last year was less than 2000 tons, but this year, output is anticipated at 4000 to 5000 tons.

In general, the many headaches due to the nature of titanium will simply have to be lived with, the group concluded. In view of its unexcelled advantages for aircraft use, industry can expect to look forward to struggling with the metal's drawbacks for some time. Nevertheless, titanium, it was pointed out, is the only structural metal known to have an endurance limit consistently higher than half its tensile strength, and its alloys are superior to all usual engineering metals in strength-weight ratio. For example, when the symposium moderator turned the discussion to such technical matters as coefficients of expansion during heat-treating, one supplier was impelled to stand up and frankly say: "You have heard of people who are ahead of their times. That question is ahead of us . . . so are changes in size, and other details. There are many months of work to be done." Such considerations led participants at the symposium to take a charitable view toward aircraft designers, who, they feel, are pushing for production before the necessary "know-how" is in hand. The position of the Solar Aircraft Company in relation to this problem was made very clear: as a pioneer engaged in the development of titanium techniques and applications ever since the commercially pure metal became available from the mills two or three years ago, the company faces actual contract commitments for the delivery of parts and assemblies in volume. Moreover, it was pointed out, the firm's customers are outlining titanium specifications comparable to the high-precision work customarily performed on the range of stainless and high-alloy steels which the company has long been turning out in its two works at Des Moines and San Diego.

Asked to gaze into the crystal ball and look a year ahead, the mill representatives said they felt that more specialised alloys would undoubtedly be developed—one alloy particularly suitable for forging, another for sheet metal, and so on. Several thought that economies would enter in more strongly as time goes on—for example, fabricators who need deep-drawing stock would order it at a premium price; others who do not need the same properties would buy standard stock at a lesser price. "Our problem right now is to decrease the cost of titanium," one spokesman for the mills said. "Every time we add another specification, that interferes. These matters of size, finish and other variances will diminish as the mills gain more experience."

Summarising the points covered, the moderator of the meeting arrived at the following general conclusions: (1) The bend strength and formability of titanium sheets are not yet uniform and can vary from sheet to sheet. Titanium suppliers are still working on the rolling of high-strength alloy sheets that will vary less than 5 per cent to 8 per cent from true flatness; (2) the technical standards for the analysis of titanium and its alloys have not yet been sufficiently established and are needed to speed progress; (3) supplies of special shapes and alloys of titanium cannot be obtained as rapidly as needed; (4) the American titanium producers are working on the development of specialised alloys for forging, sheet metal fabrication, and other requirements; (5) the suppliers of titanium alloys admittedly are still learning.

## Large Turbo-Generator With Liquid-Cooled Stator

The first large American steam turbo-generator with liquid-cooled stator conductors has been shipped from the Schenectady Works of the General Electric Company to the power station of the Cleveland Electric Illuminating Company at Eastlake, Ohio. The unit consists of a tandem-compound turbine rated at 208MW and its connected generator which is capable of producing 260MVA. It is believed to be the largest 3600 r.p.m. turbo-generator in the world. The innovation of circulating a cooling liquid through hollow conductors will be used in the stator portion of the turbo-generator. Most American generators are to-day cooled by circulating hydrogen gas through passages in the magnetic portions of the rotor and stator. This new method of liquid cooling is considered to be a major step in the development of generators of a large capacity. Consequently, significant increases in the capabilities of generators can be accomplished without increasing their physical dimensions. The higher capabilities result from a more efficient removal of heat produced during the generation of electricity. Other technical aspects of the new generator include gas cooling of the conductors in the rotating field winding, an improved grain-oriented strip steel in the magnetic portion of the armature, and an improved insulation.

General Electric also supplied the three conventional 125MW hydrogen-cooled turbo-generators for the Eastlake station. The sets were delivered during the last three years and are now in operation. Upon installation of the conductor-cooled turbo-generator, the total capacity of the Eastlake Station will be raised to 660MW.

## First Critical Nuclear Experiment Facility in Private Industry

The first American permit to construct a critical experiment facility for the conduct of nuclear reactor core tests in private industry has been granted to the Babcock and Wilcox Company by the U.S. Atomic Energy Commission. The facility will be situated on the same site as the fuel element fabrication plant which the firm is now building near Lynchburg, Virginia. Both installations are expected to be completed in April. The critical experiment facility will be used to test the nuclear characteristics of a full-scale atomic reactor without generating appreciable quantities of heat. Physicists and reactor designers will use the information obtained from these experiments to confirm their theories and calculations and to establish the final distribution of fissionable, fertile and structural material. The facility will be 53ft wide and 109ft long, and is designed for both critical experiments and proof testing of reactor components. It will house critical assemblies, a control room, laboratories, a storage vault, a sub-assembly room, a counting room, machine shops and offices. The critical assembly area will be surrounded by concrete walls 3ft thick, and the vault area for storing radioactive materials will also be separated from the other areas by special heavy walls.

## Nuclear Research Reactor at M.I.T.

The Massachusetts Institute of Technology has selected A.C.F. Industries, of New York, to design its nuclear research reactor. Part of the funds for the reactor are already available, and if the rest of the funds are secured construction will begin once the U.S. Atomic Energy Commission and other authorities have given their approval. The construction work would also be done by the A.C.F. Industries, through its nuclear energy products division. A final decision on a site has not yet been made. M.I.T. announced in 1954 that it would build a reactor as a part of a 7,000,000 dollar programme for new laboratories constituting a memorial to the late Karl Taylor Compton. Last June it was announced that the reactor would be a "domesticated" unit, devoted to non-secret research on peaceful use of the atom. It will have a power of 1MW, the same as that planned for a reactor being constructed at the University of Michigan, and it will operate at a temperature of only 104 deg. Fah.—"cool" compared to reactors which produce atomic power. The M.I.T. reactor, which will be the first to be constructed in New England, will be used for training students in nuclear engineering and for research in such fields as medical therapy, solid-state physics, sterilisation of food, biology, testing of industrial materials and design of future reactors. In design, the reactor will be similar to the one known as the "CP-5" at the Argonne National Laboratory, using as fuel an alloy of U235 and aluminium set in a gas-proof tank of heavy water.

## Procurement of Zirconium and Hafnium for Reactor Use

The U.S. Atomic Energy Commission recently announced an expanded programme for the procurement of high-purity zirconium metal and hafnium oxide to meet increasing short and long-range reactor development requirements. The major portion of the procurement is to meet the requirements of the Department of the Navy for its scheduled projects. The remainder is to meet the growing needs of the Commission's reactor development programmes. To provide an assured future supply of the materials, long-range contracts have been signed with three new commercial suppliers who were among ten firms which submitted proposals in response to an invitation by the Commission. These three contracts, covering a five-year period, call for the annual delivery of 2,200,000 lb of zirconium, subject to the availability of funds, at a cost of about 14,000,000 dollars a year.

The new long-range suppliers are the National Distillers Products Corporation, which will supply 1,000,000 lb annually from new facilities to be constructed at Ashtabula, Ohio; the N.R.C. Metals Corporation, a subsidiary of the National Research Corporation of Cambridge, Massachusetts, which will supply 700,000 lb annually from a plant to be constructed near Pensacola, Florida, and the Carborundum Metals Company, which will supply 500,000 lb annually from a new plant to be constructed at Parkersburg, West Virginia. The contracts are for fixed unit prices which are subject to revision within established ceilings at the end of each year of production. Production is expected to begin during the latter part of 1957 at the new works which are to be financed entirely by the suppliers.

# Personal and Business

## Appointments

MR. GUY CHESHAM has been appointed public relations officer of the Machine Tool Trades Association.

PROVOST A. MACRAE, of Dingwall, has been appointed a member of the North of Scotland Hydro-Electric Board.

MR. R. D. WELLINGTON has been appointed assistant to the general manager of Square D, Ltd., 100, Aldersgate Street, London, E.C.1.

MR. W. G. P. FRASER has been appointed a director of Mavor and Coulson, Ltd., Bridgeton, Glasgow. He has been the company's accountant since 1947.

MACKAY INDUSTRIAL EQUIPMENT, Ltd., Feltham, Middlesex, states that Mr. Michael F. Kelly has been appointed south-eastern area tractor representative.

MR. R. C. YATES has been appointed a director of George Ellison, Ltd., Perry Barr, Birmingham, and of its associated companies, Tufnol, Ltd., and Alfred Ellison, Ltd.

REGENT OIL COMPANY, Ltd., has announced the following appointments :—Mr. F. N. S. Evans, fuel oil manager ; Mr. N. Craven-Jones, manager of the Midland branch.

TECALEMIT, Ltd., Plymouth, announces the appointment of Mr. S. C. Kennett as assistant sales manager in the northern region, and of Mr. A. Jefferies as accessories representative in the northern region.

THE MINISTER OF SUPPLY states that Mr. W. H. Stephens has been appointed deputy director (equipment) of the Royal Aircraft Establishment, in succession to Dr. F. E. Jones, who is retiring from Government service.

MR. J. W. MORISON, M.I.E.E., has been appointed deputy chairman, general manager and chief engineer of the Electricity Authority of Cyprus. He succeeds Mr. J. O. Hall, who has had to tender his resignation for health reasons.

MR. M. W. BOYCE has been appointed managing director of Black and Decker (Australasia) Pty., Ltd. For some years he has been marketing manager of Black and Decker, Ltd., Harmondsworth, in which position he is succeeded by Mr. J. P. Jamieson.

BRISTOL AIRCRAFT, Ltd., states that Mr. D. S. Stewart has been appointed manager of "Britannia" production. He succeeds Mr. F. J. Chard, who has taken up a new managerial appointment in the company concerned with the defence programme.

JOHN THOMPSON WATER TUBE BOILERS, Ltd., Wolverhampton, states that Mr. J. W. Kendall has been appointed to a senior advisory position, concerned in particular with nuclear power developments. Mr. Kendall was previously on the staff of the United Kingdom Atomic Energy Authority (industrial group).

LLOYD'S REGISTER OF SHIPPING has announced the following elections by its general committee :—Sir Ronald Garrett, chairman ; Sir Guy Ropner, deputy chairman and chairman of the sub-committees of classification ; Mr. R. M. Turnbull, vice-chairman of the sub-committees of classification ; Mr. A. C. Grover, deputy chairman and treasurer.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., Trafford Park, Manchester, has announced the following appointments in the switchgear department :—Mr. J. C. Dawson, A.M.I.E.E., sales manager ; Mr. J. E. Stubbs, A.M.I.E.E., engineer-in-charge, switchgear projects engineering division ; Mr. G. Cluley, M.I.E.E., consultant, switchgear engineering department.

THE MINISTER OF SUPPLY has approved a reorganisation of senior engineering posts in the Ministry, and consequently the following appointments have been made :—Sir Stuart Mitchell, M.I.Mech.E., at present controller, guided weapons and electronics, is to be controller, Royal Ordnance Factories, and head of the Ministry's engineering staff ; Mr. A. T. Barnard, A.M.I.C.E., is to be director-general of inspection (a new post), and Mr. R. Ratcliffe, M.I.Mech.E., is to become deputy director-general of ordnance factories.

## Business Announcements

COLT VENTILATION, Ltd., has opened a new head office at Surbiton, Surrey.

SIR G. IVOR THOMAS has resigned from the board of Rubber Improvement, Ltd.

MONKS AND CRANE, Ltd., has opened a new head office and showrooms at Garretts Green Lane, Sheldon, Birmingham, 33.

THE DIESEL ENGINEERS AND USERS ASSOCIATION is moving on June 25th to 19, Old Queen Street, London, S.W.1 (telephone, Trafalgar 5597).

BRITISH INSULATED CALLENDER'S CABLES, Ltd., states that as from July 1st the telephone number of its Cambridge depot will be Cambridge 55451.

R. B. PULLIN AND CO., Ltd., Phœnix Works, Great West Road, Brentford, is now making various precision instruments produced by The Kearfott Company of the U.S.A.

THE HUNSLET ENGINE COMPANY, Ltd., states that its London office is being moved on July 2nd to Locomotive House, 30–34, Buckingham Gate, S.W.1 (telephone, Abbey 7127).

LEONARD SMITH (ENGINEERS), Ltd., Abford House, Milton Road, London, S.W.1, states that it is dealing in this country with the spray driers, flash drying plant and air heaters made by Anhydro A/S, Copenhagen.

ELLIOTT BROS. (LONDON), Ltd., states that arrangements have been made for National Cash Register Company, Ltd., to market in this country the Elliott "405" electronic data processing systems for business and accounting applications.

DONVIN INSTRUMENTS, Ltd., Electrin Works, Winchester Street, Acton, London, W.3 (telephone, Acorn 4995), states that it now has a repair service for electrical indicating and measuring instruments and photographic exposure meters.

NU-SWIFT, Ltd., Elland, Yorkshire, states that it has made arrangements to manufacture in this country and sell in most countries of the world the "Safe-T-Meter" dry powder extinguisher made by Safety First Products Corporation, Elmsford, New York.

THE NORTHERN IRELAND GOVERNMENT states that the Directorate of Scientific Development, Ministry of Commerce, is now known as the Department of Industrial and Forensic Science (Ministry of Commerce), 5–11, Verner Street, Belfast (telephone, Belfast 31722).

THE INTERNATIONAL FURNACE EQUIPMENT COMPANY, Ltd., Aldridge, Staffs, has made an agreement to manufacture and sell the heat-treatment furnaces produced by Holcroft and Co., Detroit, U.S.A. The agreement covers Great Britain, Australasia, and all British Colonies and Dominions except Canada.

## Contracts

THE ENGLISH ELECTRIC COMPANY, Ltd., has received a contract for two 200,000kVA, three-phase, 60-cycle, 154/13·8kV transformers from the Tennessee Valley Authority of Chattanooga, for the Reynolds power substation. The value of the contract is approximately £200,000 and the transformers are to be manufactured at the company's Stafford works.

## Miscellanea

PUNCHED CARD ACCOUNTING IN INDUSTRY.—A new film produced by the British Tabulating Machine Company, Ltd., entitled "The Twentieth Century Touch," provides an insight into the applications of Hollerith punched card accounting in widely different fields such as a light engineering factory, a large textile mill, and a cod liver oil refinery. It shows how punched card accounting provides an immediate and accurate appreciation of essential figures relating to production, costing and sales. The jobs shown in detail in the film include the calculation of P.A.Y.E., and the preparation of payrolls ; production efficiency statements and job costing ; purchase and stores control. Of general interest is the "pulled card scheme," which includes the production of factory orders and despatch notes, and the corresponding invoices.

WATERWAYS IMPROVEMENT SCHEMES.—The British Transport Waterways Division has announced further schemes of improvement and expansion on waterways in the North-East, at an estimated cost of £216,500. On the Sheffield and South Yorkshire Navigation the single-chamber lock at Long Sandall, at present 70ft long and 18ft 10½in wide, is to be reconstructed as a double-chamber lock 22ft wide with an overall length of 215ft. The new lock will be able to accommodate craft carrying up to 250 tons (the present limit is 90 tons), and will thus remove a serious bottleneck between Goole and Hexthorpe. On the Aire and Calder Navigation the fleet of steel compartment boats used to carry coal in tug-hauled "trains" from Yorkshire collieries to Goole Docks for shipment is to be augmented by the purchase of fifty new compartments. This strengthening of the fleet will enable British Transport Waterways to deal with the progressively increasing traffic carried by the compartment boat service, a traffic which has increased from 396,000 tons in 1948 to 680,000 tons in 1955. The new compartments will be constructed by Head, Wrightson and Co., Ltd., Stockton-on-Tees. A contract for dredging a length of the River Trent below Cromwell Weir, about 5 miles downstream from Newark, has been placed with Dredging and Construction, Ltd., King's Lynn.

RESEARCH ON HEARING.—On page 799 of our issue of December 2, 1955, we referred to the work of the National Physical Laboratory on equal-loudness relations. The May issue of the *British Journal of Applied Physics* presents the results of this work in a paper by D. W. Robinson and R. S. Dadson. The results are based primarily on a group of ninety persons who received thirty tests each, but a series of over a hundred tests on a team of thirty show barely distinguishable results. All these people were otiologically normal. For frequencies above 1000 c.p.s. variations associated with the age of the listener must be taken into account. The paper indicates the causes of some of the discordant factors in earlier determinations, and the Institute of Physics expects that it will be a step towards agreement on an international standard set of equal-loudness contours.

MR. F. CARLETON ANDERSON.—We have learned with regret of the death, on June 8th, of Mr. Frederick Carleton Anderson, a founder and past chairman of the Harland Engineering Company, Ltd. Mr. Carleton Anderson, who was eighty, was born at Glasgow, and was educated in New Zealand, and at the Royal Technical College, Glasgow. In the early part of his engineering career he spent some years on the staff of D. Selby Bigge and Co., consulting electrical contractors, and in 1903 he went into business on his own account with Mr. C. A. Atchley and the late Mr. Bowden to form the original partnership which became the Harland Engineering Company, Ltd. Mr. Anderson was for a time sales director, and then chairman of the company until 1943. After he retired from the board in 1952 he continued to take a keen interest in all activities of the company and especially in matters relating to the Harland "25 Year" club. He was a past-president of the Manchester Association of Engineers and a member of the Institution of Electrical Engineers.

SCALE PREVENTION IN COOLING WATER INSTALLATIONS AT A STEELWORKS.—We have received from Aquastat, Ltd., Romney House, Tufton Street, London, S.W.1, some details about the "Aquastat" water treatment appliances that are to be installed at the Chimbote steelworks in Peru. These appliances treat hard boiler-feed water or cooling water by passing it through a Monel metal electrode, in such a manner that sludge, which can be easily removed, is formed in place of scale. Apparently the physical theory of this process is not well understood, but its applications are successful, and only a small quantity of power is consumed. The installations for the Chimbote steel works are capable of treating over 5,000,000 gallons of water daily. They are to be used to treat the water cooled electrode glands, furnace doors, reheat furnaces and water cooled bearings of the rolling mills. Also, they are to protect the domestic hot water service in this steel works. The "Aquastat" process was specified by Ramseyer Miller and Co., of New York, the consulting engineers, and the plant was ordered by Messrs. Delattre and Frouard of Paris, the general contractors for the Chimbote steel works.

INSTITUTION OF NAVAL ARCHITECTS.—At a meeting of the Institution of Naval Architects, held in London on June 7th, Commander Peter Du Cane, R.N., presented a paper on "The Planing, Performance, Pressures and Stresses in a High-Speed Launch." The paper deals with the construction of a 68ft high-speed, hard chine launch designed for air/sea rescue purposes, and discusses the use of aluminium alloys and fibreglass laminate as building materials. A midship section shows the structural arrangements adopted, in which the framing, longitudinals and bottom plating are of welded aluminium alloy and the side shell is of "Fibreglass." A note is given regarding the hull form and the results of tests with an alternative round bilge form. It is stated that speed in excess of 40 knots and the ability to maintain a high proportion of maximum speed in a seaway was a paramount requirement in the design. Recorded measurements were made of planing pressures, accelerations and bottom plating stresses in the course of the trials made to establish the suitability for service conditions and the paper describes the trials and records details of performance, and the method of taking the various measurements.

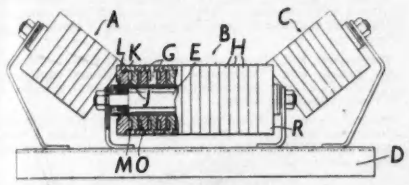
# British Patent Specifications

*When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. each.*

## CONVEYORS AND TRANSPORTERS

**749,646.** August 21, 1953.—IMPACT IDLER ROLLERS FOR BELT CONVEYORS, Sutcliffe Machinery, Ltd., Midland Bank Chambers, Market Place, Dewsbury, and Albert Glover, The Cottage, Brock-o-dale Woods, Wentbridge, Yorkshire. (*Inventors : Richard Joseph Sutcliffe and Albert Glover.*)

The invention relates to impact idler rollers for supporting an endless belt conveyor, which at the point where material is loaded on to the surface has to withstand the shock of impact. The assembly

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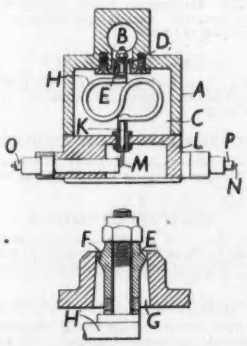
shown in the drawing comprises three rollers *A*, *B* and *C*, mounted on brackets on a base plate *D* so as to "trough" the belt of a belt conveyor. Each roller has a central core member, including a spindle *E* with an outer shell *G* revolving thereon. Mounted on the core are several annular members *H* of a resilient material such as rubber. The members, with the exception of those positioned at each end of the roller, each have inner and outer flanges *J* and *K* respectively, so that when the members *H* are assembled they present a continuous surface at both the inner and outer diameters. Part of the outer flange is cut away to provide a shoulder *L*. The web interconnecting the flanges is of a thickness less than that of either flange and the outer flange extends axially from the web for a greater distance than the inner flange. Thus, one face of each member has a shallow concentric recess *M* while the other face has a concentric boss *O*, and when the members are assembled on the core, the outer flange of one member fits on the shoulder *L* of the adjacent member while the boss *O* abuts the inner flange *J* of the adjacent member on the other side. There is, therefore, formed between adjacent members an annular air filled cavity. As can be seen the end members are each of slightly different cross section as a flat surface must be presented at each end of the roller. These end members are also formed to accommodate a clamping ring which fits over the core and is held in place by a circular spring clip and maintains the assembled annular members in a state of compression.—*May* 30, 1956.

## VALVES

**749,540.** October 14, 1953.—TEMPERATURE-RESPONSIVE MODULATING VALVES, The English Electric Company, Ltd., Queen's House, 28, Kingsway, London, W.C.2. (*Inventors : John Oliver Philip Hughes and Roy Starmer.*)

The invention relates to a temperature-responsive modulating valve for regulating and eventually shutting off the fuel supply to a gas turbine engine by throwing open a spill line when the inlet temperature of the gas turbine exceeds a predetermined maximum.

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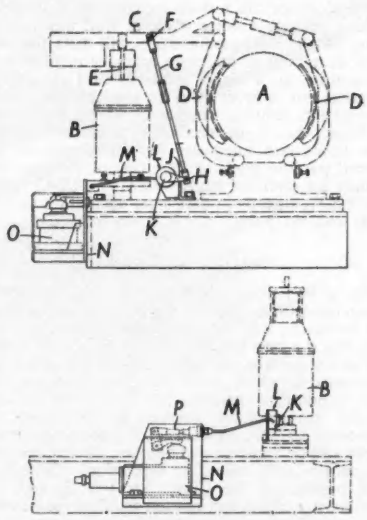
Referring first to the upper view, the valve casing *A* has a pressure compartment *B* and a relief compartment *C* separated from one another by an orifice *D* in which a valve body *E* is axially movable. The pressure compartment is connected to the spill line, and the relief compartment *C* to the fuel tank or fuel pump intake of a gas turbine engine having spill burners. The valve body *E* has a circular knife edge *F* (shown in the lower view) which leaves an annular gap between its circumference and the bore *G* of the orifice *D*. This bore is preferably conical, so that by the axial movement of the valve body the width and, accordingly, the free cross-section area of the annular gap, is varied. The valve body *E* is attached by means of a nut to the free end of a bourdon tube *H*, the other end of which is fixed to an adapter *K* mounted in the base *L* of the valve casing. Through the adapter *K* the interior of the bourdon tube is put in communication with a capillary tube *M*, which is connected to a mercury boiler in the inlet of a gas turbine engine. In the case of a gas turbine plant having more than one, say, two combustion chambers, the device described may be duplicated, with two or more orifices *D* arranged in parallel between the pressure compartment *B* and the relief compartment *C*. Another orifice is then controlled by a separate valve body and bourdon tube connected by another capillary *N* to a mercury boiler arranged in the outlet of the other combustion chamber. The capillaries *M* and *N* are protected by tubes *O* and *P*, respectively. In operation the bourdon tube moves the valve body axially in the orifice in response to the expansion of the mercury. When the expansion exceeds a predetermined value, the valve body emerges from the orifice and throws a wide area open to the fuel from the pressure side to the relief side, whereby the pressure on the pressure side is reduced to substantially the value on the relief side of the valve.—*May* 30, 1956.

## ELECTRICAL ENGINEERING

**749,522.** June 16, 1953.—PROTECTION EQUIPMENT FOR ELECTRIC MOTORS, Richard Sutcliffe, Ltd., Universal Works, Horbury, Wakefield, Yorkshire; Dennis Samuel Hill, 46, Elmwood Grove, Horbury, Yorkshire; Ivor Johnsor, 11, Stannard-Well Lane, Horbury, Yorkshire, and Peter Newsome Metcalfe, 24, Cambridge Street, Normanton, Yorkshire.

The invention relates to protection equipment for electric motors provided with brakes and has particular reference to protection equipment for the electric motors of underground conveyors. The

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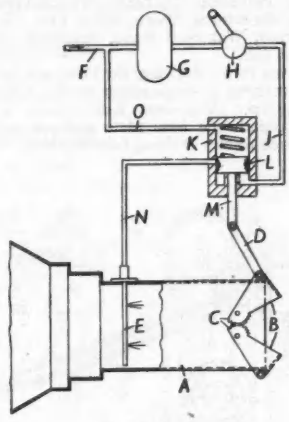
conveyor and its driving motor are shown in the drawing. Braking power is applied to the driving motor *A* by an electro-hydraulic thrustor or a solenoid *B* which controls the movement of a brake operating lever *C* connected to brake shoes *D*. The solenoid operating plunger *E* works to its fully extended position in disengaging the brake. Pivotally connected at *F* with the brake lever *B* is an adjustable link *G* whose other end is pivotally joined to a small lever *J*. The other end of this is secured to a spindle *K* in a cable operating device *L*. Movement of the lever rotates the spindle to move cable *M* extending from the cable operating device. Secured on a bracket *N* is a second switch *O*. This switch incorporates a spring which tends to move its contacts to their "off" position. The end of cable *M* remote from a cable operating device *L* is connected to a system of levers *P* which is arranged so that longitudinal movement of the cable as a result of the upward movement of the brake lever *C* to release the braking power causes the switch *O* to operate. The second switch is in parallel connection with another switch, not shown, referred to as the first switch. The contacts of the first switch are normally closed and it is operated by a relay energised on closure of the main control switch. After a predetermined time delay, for example, five seconds, the energised relay of the first switch opens its contacts. Thus, in use, if braking is not removed from the driving motor within the predetermined time, then the first switch breaks the current supply at the end of that time. If, however, the braking has been removed, closure of the contacts of the second switch maintains the current supply when the contacts of the first switch are opened by the relay.—*May* 30, 1956.

## JET ENGINES

**749,745.** March 14, 1952.—FUEL CONTROL MEANS FOR JET-PROPULSION ENGINES, Joseph Lucas (Industries), Ltd., Great King Street, Birmingham, 19. (*Inventor. : Charles Herbert Bottoms.*)

In some forms of jet-propulsion engines, provision is made for admitting liquid fuel to a burner in the jet pipe into which the hot gases flow from the combustion chamber, this fuel co-called "reheat" fuel serving to supplement the heat content of the gases after work has already been done by them in a turbine. The exit end area of the jet pipe can be varied by means




No. 749,745

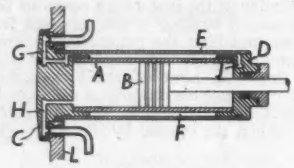
of flaps, and it is desired that the end shall be fully open when reheat fuel is to be supplied. The invention has as its object to ensure that reheat fuel cannot be supplied otherwise than with the exit end of the jet pipe fully open. In the arrangement shown in the drawing, the discharge end of the pipe is at *A*, and on the end is a pair of pivoted flaps *B* of the so-called eyelid type for controlling the effective area of the exit. The flaps are connected by toothed segments *C* and one of them is connected by a link *D* to the flap actuating and fuel controlling means. The reheat burner in the jet pipe *A* is shown at *E*, liquid fuel being supplied to the burner by a pipe *F* connected to the flap-actuating and burner control means through a pump *G*, a control valve *H*, and a pipe *J*. The control comprises a cylinder *K* and a spring-loaded piston *L*. From the piston extends a rod *M* connected to the link *D*. The piston also controls the entrance to a pipe *N* leading to the burner. Further, the cylinder is connected by a pipe *O* to the fuel supply pipe *F*. When the reheat burner is not in action, the various parts occupy the positions shown in the drawing with the valve *H* closed and the pump *G* at rest. When it is required to bring the reheat burner into action, the valve *H* is opened and the pump *G* set in motion. The fuel pressure in the pipe *J* then moves the piston *L*, causing the flaps *B* to be moved into their fully opened position. The piston then uncovers the entrance to the pipe *N*, enabling fuel to pass from the cylinder *K* to the burner. At the same time, in the upper part of the cylinder any fuel is returned to the supply pipe *F* along the pipe *O*. To discontinue the supply of fuel to the burner the pump *G* is stopped and the valve *H* closed. The piston *L* and the flaps *B* are then returned to the position shown, due to the combined action of the spring and the pressure of fuel in the pipe *O*.—A modified arrangement is also shown in the specification.—*May* 30, 1956.

## HYDRAULIC MACHINERY

**749,564.** December 21, 1953.—HYDRAULIC CYLINDER ASSEMBLIES, Douglas Fraser and Sons, Ltd. Westburn Foundry, Arbroath, Angus, Scotland. (*Inventor : Walter Brown Ruark.*)

Referring to the drawing, *A* is a hollow cylinder in which a piston *B* is reciprocable. *C* and *D* are ported end caps at both ends of the cylinder. *E* is a tube coaxial with and surrounding the cylinder. The tube *E* is spaced from the outer wall of the cylinder to

provide an annular conduit *F* communicating at one end with an inlet connection *G* terminating in the end cap *C*. The end cap is formed with a passage *H* connecting the interior of the cylinder with the source of supply of operating fluid. The end cap



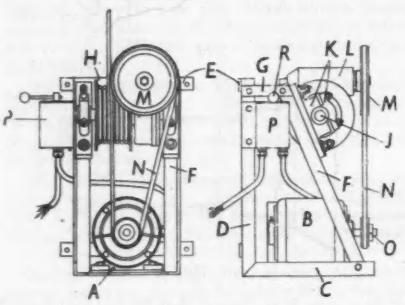

No. 749,564

*D* has a passage *J* connecting the other end of the conduit *F* with the interior of that end of the cylinder. A mounting plate *L* affords a seat for the end cap *C* and carries pipes for supply and exhaust of operating fluid to and from the passages *G* and *H*. Four different designs are shown in the specification.—*May* 30, 1956.

### HOISTS

**749,555.** November 27, 1953.—WINCH-TYPE HOISTING MECHANISM, Shorts (Lifts), Ltd., 13, Walker Terrace, Wakefield Road, Bradford. (*Inventor: Allan Gill.*)

Referring to the drawing, the hoist unit includes a base *A* carrying a single-phase electric motor *B* of about ¼ h.p. Angle-iron base frames *C* extend across beneath the base plate and are welded to vertical side frames *D* rising from the base. The two




No. 749,555

side frames are connected together at their upper ends by a transverse upper plate *E* and the framework is completed by further side members *F* which may be in a slightly inclined plane, and which are connected to the side frames *D* by rigid links *G*. A winding drum *H* is mounted on the side members *F*. The drum shaft *J* is carried in end brackets and bearings *K* and carries an enclosed worm drive *L* the worm of which has a V-groove pulley *M* on the end of its shaft. A V-belt *N* connects this pulley with a driving pulley *O* on the motor shaft. Power for the motor is supplied through a control switch *P*. Hoisting or pulling operations can be carried out by use of this "dead man" switch.—*May* 30, 1956.

## Launches and Trial Trips

ARGYLLSHIRE, refrigerated cargo liner; built by The Greenock Dockyard Company, Ltd., for The Clan Line Steamers, Ltd.; length between perpendiculars 497ft, breadth moulded 69ft, depth moulded to upper deck 41ft 7in, deadweight 11,250 tons on 28ft 3in mean draught, service speed 16½ knots, cargo capacity 600,000 cubic feet bale; twelve passengers; six holds, one 105-ton, two 40-ton, four 15-ton, four 7-ton, and twelve 5-ton derricks, electric deck machinery, four 270kW diesel-driven generators; one set of Parsons triple-expansion, double-reduction geared reaction turbines, service s.h.p. 10,500 at 112 propeller r.p.m., maximum s.h.p. 11,550 at 115·5 r.p.m., two Babcock and Wilcox single-pass water-tube boilers supply steam at 415 lb per square inch and 750 deg. Fah. Launch, May 23rd.

NORTHERN GULF, oil tanker; built by the Netherlands Dock and Shipbuilding Company, for Afran Transport Company of Monrovia; length between perpendiculars 660ft, breadth moulded 90ft 6in, depth 48ft, displacement 48,440 tons, deadweight 37,000 tons, speed 16 knots at 36ft 5½in draught; four 1000 tons per hour turbine-driven pumps, four 150 tons per hour steam-driven reciprocating stripping pumps; two 550kW turbine-driven alternators and one 100kW diesel-driven alternator; one set of N.D.S.M.-Parsons double-expansion, double-reduction geared turbines, 13,750 normal s.h.p., 15,000 maximum s.h.p., steam supplied at 600 lb per square inch gauge and 800 deg. Fah. by two N.D.S.M.-Babcock and Wilcox boilers. Launch, May 26th.

FORT ROYAL, banana carrier; built by the Chantiers de Provence for the Compagnie Generale Transatlantique; length overall 377ft 4in, length between perpendiculars 346ft 1½in, breadth moulded 51ft 10in, depth to upper deck 36ft 1in, maximum draught 21ft 4in, deadweight 2500 tons, displacement 6000 tons, speed 17 knots; twelve passengers; four holds, complement of 3-ton derricks, electric deck machinery, three 250kW diesel-driven generators; Burmeister and Wain, two-stroke, single-acting "10,62 V.T.F. 115" diesel engine, 6000 b.h.p. at 150 r.p.m. Trial May.

RUTH LAKE, ore carrier; built at the Wallsend yard of Swan, Hunter and Wigham Richardson, Ltd., for The Iron Ore Transport Company, Ltd., of Canada; length overall 661ft 7½in, length between perpendiculars 630ft, breadth moulded 87ft, depth moulded to upper deck 45ft 6in, draught 34ft 0⅝in, deadweight 31,000 long tons, service speed 14¾ knots; three ore holds, wing ballast tanks, four 4500 gallons per minute horizontal centrifugal ballast pumps, turbine-driven, four vertical duplex stripping pumps, two 5-ton and two 7-ton derricks, steam winches, two 500kW geared turbo-alternators, one 150kW diesel-driven emergency alternator; one set of double-reduction geared, compound turbines by The Wallsend Slipway Engineering Company, Ltd., 12,500 service s.h.p. at 105 propeller r.p.m., two Foster Wheeler "D" boilers supply steam at 600 lb per square inch and 850 deg. Fah. Trial, June 5th.

## British Standards Institution

*All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.*

### SCREWED STUDS: PART I: GENERAL PURPOSE STUDS

No. 2693 : 1956. Price 3s. 6d. This is the first British Standard to give full information, including limits and tolerances for the threads, for screwed studs intended for general use. The principle adopted is that of mating an oversize stud with a standard tapped hole and the amount of oversize and the thread tolerances specified are those considered suitable for most purposes. The very wide range of applications for which studs are used makes it impossible to provide a single grade of stud which, while being economic to manufacture, will meet the most arduous as well as the more ordinary requirements. Discussions on a higher grade of stud are now in progress, but in order to make available the general information relating to overall dimensions, length of thread, &c., it was decided to issue this, together with limits and tolerances for the threads of the general purpose grade as Part One of the standard. Details are given for studs with UNF, UNC, B.S.F. and B.S.W. threads in diameters up to 1½in and for studs with No. 2 and No. 4 B.A. screw threads.

### SMOKE ALARMS

No. 2740 : 1956. Price 3s. In consequence of recommendations made by the Beaver Committee on Air Pollution, the British Standards Institution has now issued a new standard for simple smoke alarms and alarm metering devices. It is the first of a series of standards which B.S.I. was asked to prepare. This standard is designed particularly to help the smaller manufacturer combat air pollution and economise on fuel; by following its recommendations he can also be confident that his plant is being operated to conform with impending legislation. During the final passage of the Clean Air Bill through the Commons, a clause was inserted enabling the Government to make regulations requiring smoke measuring instruments to be installed and used. Complex measuring equipment (for which another standard is being prepared) has been available for a number of years, but because of its relatively high cost it has often been beyond the reach of some firms. The instruments covered in this standard normally consist of three fixtures to be installed on industrial chimneys: (*a*) a light source such as a lamp and projector; (*b*) a receiving unit consisting of a photocell and amplifier, and (*c*) a visual or aural alarm. When the alarm bell rings or the light flashes, it will be the responsibility of the plant operator to adjust firing conditions so that smoke will be reduced. In addition to the alarm mechanism, two kinds of simple metering device are specified which can be used to record the number of alarms given and their duration. Records from such meters could be used by manufacturers as a defence in any action brought against them under the Clean Air Bill when it becomes law. It is important to note that the instruments specified in the new standard will only record black or grey smoke, not white or coloured smoke; nor will they be suitable, for example, where boilers are fed with pulverised fuel.

## Catalogues and Brochures

FERRANTI, Ltd., Hollinwood, Lancashire.—New data sheets for technical handbooks on valves and cathode-ray tubes.

GEORGE KENT, Ltd., Luton, Bedfordshire.—Publication No. TP 5007, dealing with fuel economy and its implications for management.

GIBBONS BROTHERS, Ltd., P.O. Box 19, Dibdale, Dudley, Worcs.—Leaflet illustrating continuous normalising, hardening and annealing furnaces.

MITCHELL, COLMAN AND CO., Ltd., Harcourt Street, Little Hulton, Walkden, near Manchester.—Leaflet dealing with screw and pneumatic conveying machines.

Q.V.F., Ltd., Mill Street, Stone, Staffs.—Illustrated catalogue, giving full details and specifications of the basic standard range of pipeline products manufactured by this firm.

F. J. EDWARDS, Ltd., 359–361, Euston Road, London, N.W.1.—Brochure No. 123b, describing a range of "Besco" production guillotine shearing machines. Stock list SM 456.

THE TRUMETER COMPANY, Ltd., Milltown Street, Radcliffe, Lancs.—Illustrated catalogue No. 56, giving details of mechanical, counting, measuring and registering instruments.

ALLEN WEST AND CO., Ltd., Brighton.—Leaflet giving details of adaptable remote control units, designed for operating contactor type motor starters and control equipment.

K. AND L. STEELFOUNDERS AND ENGINEERS, Ltd., Letchworth, Herts.—Leaflet illustrating quality controlled steel castings, dealing with shell moulding for the production of small intricate castings.

HOLOPHANE, Ltd., Elverton Street, London, S.W.1.—Publications dealing with "Holophane" street lighting equipment, giving details of their application in lighting control in industry, commerce and public service.

HANCOCK AND CO. (ENGINEERS), Ltd., Progress Way, Croydon.—Catalogue illustrating "Hancoplane" and "Junior" flame planers used for plate edge preparation, also in the construction of tanks and pressure vessels.

Q.V.F., Ltd., Mill Street, Stone, Staffs.—Leaflet giving details of their range of 18in diameter industrial plant in glass units, designed to extend the range and scope of glass absorption, fractionating and wash towers.

THE TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY, Ltd., Mercury House, Theobald's Road, London, W.C.1.—Folder dealing with "Telcon" railway signal control cables used in railway modernisation schemes.

STURTEVANT ENGINEERING COMPANY, Ltd., Southern House, Cannon Street, London, E.C.4.—Booklet describing the range of fans, blowers and exhausters manufactured by this company, giving their design and construction.

R. AND J. DICK, Ltd., 3, McPhail Street, Greenhead Works, Glasgow, S.E.—Folder giving details and application of "Dixlink V-Belt," designed for use where an endless unit is not suitable due either to structural restrictions or fixed centres.

HEADLAND ENGINEERING DEVELOPMENTS, Ltd., 164–168, Westminster Bridge Road, London, S.E.1.—Illustrated booklet describing "CV" tension pins, bushes, collars and bolts. These products are available in both English and metric sizes.

CROMPTON PARKINSON, Ltd., Crompton House, Aldwych, London, W.C.2.—Pocket-size booklet describing the latest Crompton fluorescent and tungsten lighting fittings, including the company's comprehensive "New-Range" equipment.

BERYLLIUM SMELTING COMPANY, Ltd., 36–38, Southampton Street, London, W.C.2.—Illustrated leaflet giving details of "Beryllium" copper moulds and dies. A data sheet is attached giving mechanical and physical properties of "Beryllium" copper alloys.

THE INTERNATIONAL MEEHANITE METAL COMPANY, Ltd., Meerion House, 4, Downside, Epsom, Surrey.—Wall chart showing the physical properties of Meehanite metal, intended for workshops, engineering offices, drawing-office staffs and buyers of castings.

BRIGHTSIDE HEATING AND ENGINEERING COMPANY, Ltd., Ecclesfield, G.P.O. Box 118, Sheffield, 1.—Catalogue dealing with heating and air treatment, compiled in five sections and headed "Technical Data," "Air Conditioning and Air Treatment," "Heating and Air Treatment in Industry," "Conditioned Comfort in Hospital and Institutional Buildings," and "General and Commercial Buildings," with each section dealing with a particular aspect of the activity of this company.

## Forthcoming Engagements

*Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the* TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

### BRITISH INSTITUTE OF MANAGEMENT

*Wed., June 27th.*—Management House, 8, Hill Street, London, W.1, "The Automatic Factory—Its Evolution and Implications," J. F. Coales, 7 p.m.

### CHEMICAL SOCIETY

*Mon. to Thurs., July 16th to 19th.*—The University College of North Staffordshire, Keele, Staffordshire, Symposium on "Chemisorption."

### INCORPORATED PLANT ENGINEERS

*Fri., June 29th.*—BIRMINGHAM BRANCH: Imperial Hotel, Birmingham, "Spring Design and the Plant Engineer," A. A. D. Brown, 7.30 p.m.

### INSTITUTE OF PHYSICS

*Wed. to Sat., July 11th to 14th.*—NON-DESTRUCTIVE TESTING GROUP: H. H. Wills Physical Laboratory, Bristol, Summer Meeting, "Physics of Some New Aspects of Non-Destructive Testing."

### INSTITUTION OF CIVIL ENGINEERS

*To-day, June 22nd.*—Great George Street, Westminster, London, S.W.1, Colonial Engineering Conference, 10 a.m.

### INSTITUTION OF ELECTRICAL ENGINEERS

*Mon. to Fri., June 25th to 29th.*—Summer Meeting, Birmingham.

### INTERNATIONAL MACHINE TOOL EXHIBITION, 1956

*To-day, June 22nd, to Fri., July 6th.*—Olympia, London.